A COMPARISON OF MILITARY AND CIVILIAN AIR CARGO SYSTEMS

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THESIS

A COMPARISON OF
MILITARY AND CIVILIAN AIR CARGO SYSTEMS

by

Roger W. Roberts

September 1979

Thesis Advisor: Robert W. Sagehorn

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The report concludes that the 463L Materials Handling System will continue to be used by MAC in the short run, and that this may sub-optimize the military air cargo function due to its necessary interface with the civilian container community.

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A Comparison of Military and Civilian Air Cargo Systems

by

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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

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DEFINITIONS

Aerial Port of Debarkation (APOD). An air base where heavy transports arrive from channel destinations or theater locations.

Aerial Port of Embarkation (APOE). An air base where heavy transports depart for channel destinations or theater locations.

Air Line of Communication (ALOC). The supply by air of forces, equipment and supplies. A total air line of communication could extend from the Continental United States to the forward edge of the battle area in an overseas theater. Thus, the ALOC includes both strategic and tactical airlift.

Airlift. MAC provides three basic types of cargo airlift, i.e., channel, special assignment and attached airlift.

1. Channel Airlift -- Regularly scheduled airlift service by MAC has been established between points where the volume of movement of non-availability of other forms of transport require airlift. Frequency of service is dictated by volume; however, a minimum of semi-weekly service is normally maintained.

2. Special Assignment Airlift - MAC provides airlift service between points not within the established channel airlift pattern or where airlift service is not otherwise available for the movement of material, generally in plane load lots.

3. Attached Airlift -- Attached airlift is the airlift provided to a military organization or command by MAC and attached to that organization or command for operational control. When aircraft are designated to provide attached airlift, operational control will be as mutually agreed upon by the Air Force and the commander concerned.

Allowable Cabin Load (ACL). The available payload or capacity of a specific aircraft after adjustments have been made for mission profile, crew and fuel weight.

Bulk Cargo. Cargo that cannot be accommodated by the conveyor system, but will fit on a 463L pallet and can therefore be processed inside the terminal building.

Cargo. Includes all items of supplies, materials, stores, baggage or equipment which are classified and transported as freight in contrast to those items which are classified and transported incidental to passenger movement.

Continental United States (CONUS). The 48 contiguous states and the District of Columbia.

Conveyor Cargo. Cargo that can be processed on the conveyor system inside the terminal building.

Civil Reserve Air Fleet (CRAF). The fleet consists of commercial aircraft operated by the civilian airlines and contractually committed to supplement the military airlift requirements as required.

Intransit Cargo. Cargo received via aircraft for rehandling, rescheduling or for change in destination and reshipment by air.

Intransit Time. The elapsed time from time of entry into, until the time of exit from, the MAC airlift system.

Manifest (Cargo). A detailed listing by type of all cargo loaded in any one conveyance.

Material Handling Equipment (MHE). Vehicular and non-vehicular equipment used for the movement of cargo.

Materials Handling System - 463L. An integrated materials handling system which is used to accomplish the air logistics and aerial delivery mission. The system consists of five separate subsystems, all of which are interdependent. These subsystems are: aircraft cargo loading, cargo ground handling equipment, air freight terminals, intransit control and freight preparation.

Military Airlift Command (MAC). The major Air Force command, and Single Manager Operating Agency, for airlift service under the Department of Defense. MAC's mission objectives are to train, equip and operate global airlift forces to insure optimum mobility and flexibility; participate in joint exercises and airborne training with the ground, naval and air forces for which the Air Force furnishes airlift support, to operate bases and worldwide air routes of communications; and to maintain a global airlift command and control system which is compatible with the overall U.S. Air Force Command and Control System to insure optimum employment of airlift forces.

Military Standard Transportation and Movement Procedures (MILSTAMP). The uniform and standard transportation data documentation and control procedure applicable to all cargo movements in the Department of Defense transportation system.

Originating (Outbound) Cargo. Material that originates on base from local vendors and other government installations in the surrounding area and is delivered to the terminal by surface shipment.

Outsize Cargo. Cargo which is too large or too heavy to fit any existing or contemplated consolidation module from the military airlift system.

Oversize Cargo. Cargo exceeding the size and weight limitations of a single 463L master pallet (108" in length; 88" in width; 96" in height; 10,000 pounds).

Permanent Air Terminal. An installation provided with permanent facilities (brick and mortar) for loading and unloading and the intransit handling of traffic (passengers, cargo, mail) which includes receiving, palletizing and processing functions.

Terminating Cargo. Cargo received by aircraft that terminates on base or is redistributed by surface shipment.

Traffic Management. The direction, control and supervision of all functions incident to the effective and economical procurement and use of airlift service.

Tons-per-day (T/D). The total air cargo workload in tons processed in an Air Freight Terminal in one day. This includes originating, terminating and intransit cargo.

Abbreviations

APOE	Aerial Port of Embarkation
APOD	Aerial Port of Debarkation
ALOC	Air Line of Communication
ACL	Allowable Cabin Load
CONUS	Continental United States
CRAF	Civil Reserve Air Fleet
MHE	Material Handling Equipment
MAC	Military Airlift Command
MILSTAMP	Military Standard Transportation and Movement Procedures
T/D	Tons-per-day

I. INTRODUCTION

There is increasing pressure, as United States troops and material withdraw from overseas bases around the world, to have available on short notice, a system to provide for a rapid movement of cargo and personnel to remote points of operation. This system includes the Military Airlift Command (MAC), the Civil Reserve Air Fleet (CRAF) and their associated personnel, equipment, and agencies which would provide immediate airlift in time of conflict or potential conflict. Specifically, MAC and CRAF have been tasked with providing military cargo airlift on short notice around the world, with major emphasis being placed on support of NATO countries.

In comparing these two separate but related agencies, with respect to cargo handling, several points are pertinent:

1. The military system relies heavily on pallets.

2. The civilian system relies to a greater extent on containers.

3. There is a lack of compatibility between military handling equipment and civilian handling equipment.

4. There is a lack of compatibility between military aircraft and civilian aircraft.

5. There is little collaboration between the military and civilian air cargo planners in aircraft design, acquisition or appurtenances.

6. The two different systems have different goals (readiness vs. profit).

7. The two systems are funded primarily through different sources (MAC through taxes, CRAF through revenues with some subsidy).

8. The public sentiment towards these separate groups, civilian air cargo carriers and the military, is quite different.

9. The needs of the two groups during peacetime are different, while during conflict they are identical.

These points are not all inclusive, but they demonstrate the divergence that exists between these two communities of military air freight carriers.

A specific piece of equipment that has grown substantially in use is the container. It emerged as a basic transportation medium some 20-25 years ago in the land-sea environment and has grown into an integral part of the rail-truck-sea intermodal transportation network. Only in this decade has the air container come into its own, but it highlights the direction towards which all civilian cargo handlers are proceeding; towards a fully intermodal transportation network utilizing containers of standard sizes to effect rapid movement of cargo. Unlike the civilian air cargo industry, the military air cargo network still relies heavily on palletization, even though containerization has proven itself more effective.

Given the recent large increases in air cargo shipments, the necessity for the military to rely on CRAF for a major portion of military air cargo movement, the mandate to have high input-output efficiency in cargo movement, rapid aircraft turnaround time, and the need to efficiently utilize aircraft space, the military must investigate all avenues available to maximize the efficiency of the military air cargo effort. It is postulated in this thesis that containers, of standardized sizes, have possible economies and efficiencies that should be examined. In light of the trend in the civilian community to shift toward higher container use, containers appear to be the transportation vehicle the military air cargo system needs to realize maximum effectiveness in air cargo movement.

II. BACKGROUND AND DEFINITION

Historians have recorded that aviation was commercialized not for passengers, but for cargo; and that cargo was specifically the United States mail. This commercialization was done in a rather haphazard manner.

On the other hand, containers appear to have been well thought out, with profit and reduced costs in mind. Sea-Land Service made the first purchase of surface-type containers in 1956 in the amount of 1000 units, and this container development has evolved into a staggering commercial business. Today, there are over 2,000,000 containers in service, being operated under many different corporate names, both owned and leased, and the growth rate continues to be massive [11].

With the ever increasing amount of cargo being shipped by air, it was axiomatic that containers would be used. Containers have been used in the air cargo industry since the late Fifties; however, containerization, as it is thought of today, did not come to the fore until the advent of wide-bodied jet aircraft. These large commercial jets, such as the Boeing 747, Douglas DC-10, Lockheed L-1011 and Airbus A-300, have brought with them the ability to ship large amounts of cargo in their belly holds utilizing unit load devices (ULD), and if freighter configured, have the ability to carry unprecendented amounts of cargo in the main

cabin. The 747 can carry more cargo than any other commercial aircraft, and is the only commercial aircraft that can accommodate two standard size containers side by side. These new aircraft brought about the design, testing, evaluation and purchase in March of 1977 of the first air-type intermodal containers. Most of these containers are 2.44x 2.44x6.00 meters (8'x8'x20') in size and are suitable to be handled in any current container handling facility. At the beginning of 1979 more than 500 air intermodal containers were available for use. The growth in this container market, although new, has been dynamic to say the least [11].

The military, unlike the commercial air carriers, already has a substantial performance proven air cargo handling system, the 463L material handling system. This system is an integrated logistics network of aircraft, pallets, and material handling equipment that is fully compatible within the military air cargo arena. The system has been in operation since the mid-fifties. However, this system is not fully compatible with containerized cargo facilities in use by many commercial cargo aircraft. The container and pallet can be accommodated by either commercial or military aircraft, but changes must be made in handling procedures and securing methods, when they are carried in the different types of aircraft. These changes necessarily mean additional time for load and offload operations. Furthermore, the military has only a limited ability to

handle containers, and if container use continues to grow at its present rate, the military could find itself dealing with a serious logistics problem when an attempt is made to employ CRAF aircraft.

These two material handling systems, one based on containers and the other based on pallets, have evolved under two separate and distinct infrastructures. There are positive and negative points with regard to each system, but an overriding positive factor about containers is growth. If the growth in container usage continues, the military will not be able to reach its full potential as a high volume air cargo carrier, if the dominant 463L cargo system continues to be employed. The container must be analyzed by the military not as a separate entity, but as an integral part of the overall military logistics system. This study, to a limited extent, is intended to draw conclusions concerning the feasibility of an all military container logistics system, specifically as it relates to air cargo.

III. INTENT AND PROBLEM DESCRIPTION

The intent of this project was to analyze the new intermodal container, the Military Van (MILVAN), and the 463L palletization system. Consideration of the intermodal container and the MILVAN has been limited to the standard 2.44x2.44x6 meter configuration, which is most prevalent. These two containers were compared with the current 463L palletization system.

Specific parameters analyzed were:

1. Cost
2. Load-unload times
3. Packing density
4. Packing efficiency
5. Aircraft utilization
6. Off-aircraft movement
7. Commonality

These items are not all of the parameters that could be investigated; rather, they represent a list of topics that bear heavily on the feasibility of using containers in the military air cargo network.

The problem, actually, is self-evident. The Department of Defense (DOD) does not have the ability to move cargo and personnel to a forward deployed site via airlift in a timely manner. This is true whether containers are used or not, and is restricted by the fact that not enough organic

aircraft plus CRAF aircraft are available to move the massive amounts of cargo needed on short notice [22:27]. This problem is aggravated by the fact that the military is placing more reliance on CRAF in case of an emergency, and CRAF airlines are using more and more containers. Even though CRAF operators modify their aircraft to comply with projected government needs, their expertise in using containers is rising due to greater use, and will decline with pallets as pallets become used less frequently. This is the heart of the problem facing military air lift. Two separate entities that are supposedly working in harmony to meet peacetime needs and projected wartime needs are actually operating two distinct and separate logistics handling systems.

Further, it appears that if these two systems were used together, they would not be able to satisfy the requirement for massive and rapid movement of cargo.

The problem, therefore, can be summarized by stating that there is a lack of military airlift capability in time of war, and the question to be answered is: What can be done to either provide the required airlift or make more efficient use of present and projected airlift capability, given some budgetary constraints?

Research attempting to answer this question was conducted utilizing various sources, listed as references and in the bibliography, and consisted generally of:

1) Naval Postgraduate School sources

2) Defense Logistics Studies Information Exchange sources

3) Trade Journals

4) Civilian container and air cargo corporations

5) Phone conversations with knowledgeable people in the field both in the military and civilian sector

6) Visit with the Navy Liaison Officer at Travis Air Force Base, Calif.

The analysis was conducted under several assumptions:

1) Civilian container use will increase, and pallet use will decrease, causing a shift in handling knowledge and expertise.

2) Containers are new and have room for improvement, while pallets have reached their state of maturity.

3) Civilian air freight firms will continue to increase their wide-body aircraft inventory, and decrease their outdated narrow-body aircraft inventory.

4) Surface modes have little bearing on the military air cargo transportation problem.

5) Military response, not cost, is the paramount objective.

IV. PRESENT CIVILIAN CONTAINER USE

The present number of air intermodal containers stands at approximately 500, compared with the 2,000,000 containers used in surface operations. The growth of both types of containers has been impressive, and is expected to continue. These container numbers are based on an expression in the industry called "Twenty foot equivalent units (TEU's)." Containers come in various shapes and sizes; however, they are totaled based on the twenty foot container. This standard is used due to the large number of twenty foot units.

Containers are used in the air industry to ship practically any item. What is evident in the air industry is the proliferation of different types of containers. The types of containers are lower deck (LD), non-standard unit load devices (ULD), standard ULD's and igloos, which are configured to the interior of aircraft fuselages.

The use of many different types of containers is on the one hand efficient, because they utilize the most amount of space, while on the other hand they create handling problems because of the diversity of containers with their various stuffing requirements and differing shapes. This specialization in different types of igloos and containers started with the advent of jets, and has become worse, with the introduction of wide-bodied jets and their associated designed-to-the-aircraft LD units.

A. PHYSICAL CHARACTERISTICS

Appendix A pictures and describes twenty and forty foot containers that are available for lease through Container Transport International (CTI). Note that all of the containers shown, with the exception of those in Appendix A-9 and A-10, are of steel construction intended for surface movement. These containers are of heavy construction, stackable six high, and fully compatible with all transportation modes except air. They can, however, be used in the air modes if the carrier and shipper are willing to pay an excess tare weight penalty.

The air-type intermodal container shown in Appendix A-9 and A-10 is quite different. It is much lighter, permitting a substantial reduction in gross weight. This is due to the types of materials (balsa wood, styrofoam, plywood, and aluminum) that are used in its construction. The air container is stackable only two high. The air containers, presently 2.44x2.44x3m and 2.44x2.44x6m, designated by the airlines as M-1 and M-2 respectively, are the only containers available for fully air intermodal container shipment.

Both types of containers, the conventional surface and the air intermodal, have the same general size and shape, and can be maneuvered into aircraft. The large differences occur when tare weight and gross weight are compared. The air container has a tare weight rating about half of the steel container, and the corner post rating creates a severe restriction on the air/land containers cargo capacity.

Seaboard World Airlines has a somewhat different container as shown in Appendix A-11. This container, of lighter weight, is not liftable by conventional handling equipment, because it was produced before the present air container standards were approved. This container is still used by Seaboard, but requires some special loading equipment.

The diversity in air container sizes is presented in Table I so the reader may fully comprehend the differing types of unit load devices (ULD) available to air carriers. The issue is further confused by Table II. This listing illustrates strictly lower deck (LD) units that add further to the large number of different types of containers utilized by the commercial carriers.

TABLE I

NATIONAL AEROSPACE STANDARD(NAS) 3610 BASIC ULD SIZES

SIZE CODE	NOMINAL DIMENSIONS	AIRLINE DESIG.
A	2.24x3.175M(88"x125")	
B	2.24x2.75M (88"x108")	
C	2.24x3.0M (88"x118")	
D	2.24x1.37M (88"x54")	
E	2.24x1.35M (88"x53")	
F	2.44x3.0M (96"x118")(10' intermodal)	M-1
G	2.44x6.0M (96"x238")(20' intermodal)	M-2
H	2.44x9.0M (96"x356")(30' intermodal)	
J	2.44x12.0M (96"x480")(40' intermodal)	
K	1.52x1.55M (60"x61")	
L	1.52x3.17M (60"x125")	
M	2.44x3.17M (96"x125")	

Source: Cargo Logistics Airlift Systems Study, Volume 1, Analysis of Current Cargo systems, p. 406.

TABLE II

SPECIFICATIONS OF SEVERAL LOWER DECK AIRCRAFT CONTAINERS

TYPE	CUBIC FEET	NET CAPACITY	DIMENSIONS(M)	TYPE OF AIRCRAFT
LD-3	150	3150 lbs.	2.0x1.52x1.62	WIDE BODY
LD-3A	120	2890 lbs.	1.19x1.52x1.62	767 series
LD-5	233	6200 lbs.	3.17x1.52x1.62	WIDE BODY
LD-7	358	10000 lbs.	2.64x2.28x1.62	WIDE BODY
LD-9	370	10200 lbs.	3.09x2.24x1.60	WIDE BODY
LD-11	240	6400 lbs.	3.18x1.52x1.62	WIDE BODY
LDL/LDN	90	2500 lbs.	1.37x1.37x1.42	ALL JETS
LD-W	75	1585 lbs.		ALL JETS

Sources (1,4,19,20)

This plethora of air containers has been presented to highlight the problems the air cargo industry faces. The industry on the one hand espouses intermodalism, which implies some sort of commonality among carriers, and on the other hand it generates and receives approval of divergent breeds of containers tailored to specific types of aircraft. This tendency must be recognized even though the thrust of this paper is towards the utilization of intermodal types of containers.

B. EMPLOYMENT AND UTILIZATION

What may appear to be a severe problem to the airlines and shippers is in fact a boom that parallels containerization growth in the surface transportation community during the 1950's.

> What is attracting shippers, forwarders and the airlines themselves to air containerization in increasing numbers? For the airlines, there is a reduction in terminal handling and documentation cost. Storage facility problems are minimized. Delays in loading have been arrested. Retrieval time has been shortened. For the shipper, packaging costs are reduced, while greater protection against pilferage and

damage is afforded goods, thereby providing a basis for lower insurance costs. And of course, there is the advantage of transit speed inherent in the mode. Shippers are also giving an affirmative nod to air containerization because of incentive programs that have developed in past years [2:12].

The emergence of wide-bodied jets, coupled with the inherent benefits of containerization in general, brought about the fully intermodal container that provides for rapid movement of goods. Exhibit 1 depicts succinctly the growth of air intermodal containers. These graphs also display the tendency of late to gravitate towards leasing companies for the suppliers of containers. This leasing arrangement has become very popular because the airlines do not have to make a capital investment, and it provides for a greater degree of cooperation between modes (the lessor acting as an intermediary).

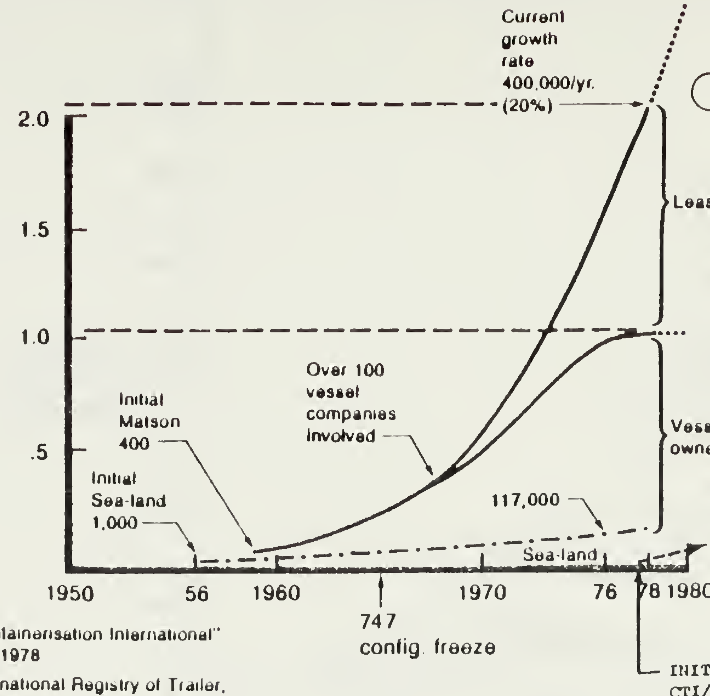
The intermediary function is not to be neglected, for there have been problems in intermodal cooperation.

> In spite of the advantages of intermodal cargo transportation, progress in bringing an integrated surface-air transportation service into being has been slow. The lengthy time required to develop through bills of lading and through rates is a good example. One of the basic reasons for this is that when multiple modes are involved the modes must work cooperatively to insure that the interests of all are preserved. This coordination may involve many complex factors such as involvement of different labor unions, diverse regulatory agencies, and various hidden costs. External factors always exist... [17:1].

The problem of integrating the surface-air modes of shipment recently received a positive "shot in the arm" through air deregulation. The proponents of intermodal transportation see deregulation as providing 1) the competitive spirit needed in the air cargo industry to

Intermodal Container Growth

(Surface)



205,000	CTI – Container Transport
155,000	Sea Containers
130,000	SSI
128,000	Uni-Flex
112,000	Interpool
93,000	ICS-Integrated Container Services
66,000	Xtra
125,000	Other Leasing Companies
1,014,000	Leasing Company Owned
148,000	Japan Consortium (6 lines)
117,000	Sea Land Service
38,000	Overseas Container Ltd
28,000	American Navigation
735,000	Other Steamship Lines
1,086,000	Vessel Owned
2,100,000	Total Containers in Service*

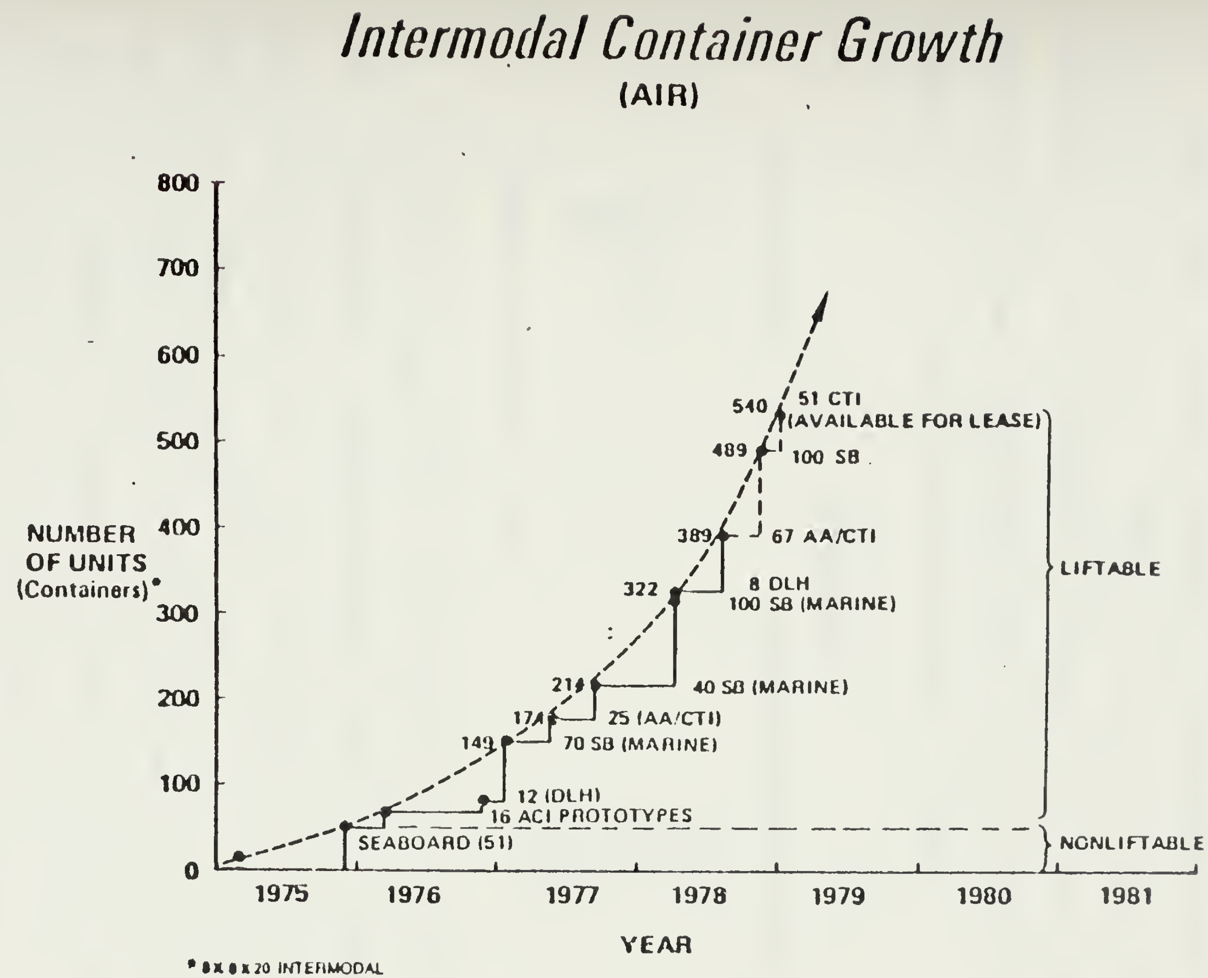
*Twenty-foot equivalent units

Sources. "Containerisation International" May 1978

"International Registry of Trailer, Container and Chassis Equipment" September, 1978

Source: Intermodal Air Freight System Progress Report, Boeing Commercial Airplane Company, Air Freight Systems Office, Seattle, March 1979.

EXHIBIT 1



Source: Intermodal Air Freight System Progress Report, Boeing Commercial Airplane Company, Airfreight Systems Office, Seattle, March 1979

EXHIBIT 2

generate new air cargo demand through reduced rates, and 2) cooperation between all shippers due to less regulation. As of yet this has not been demonstrated.

The use of intermodal containers today, though increasing at a rapid pace as more Boeing 747 freighters are acquired, is at best infrequent. Table III presents percentage information on ULD usage for the year 1976 as compiled by McDonnell Douglas Corporation under contract to the National Aeronautics and Space Administration (NASA).

TABLE III

*ULD type	Percentage of total flows
A	50.5
LD-3	25.5
LD-5/7	18.5
M1	4.5
M2	1.0
	100.0%

*refer to Table I and II

The percentage totals 100 percent due to the nature of the interrogation method used and does not include ULD's which have erratic use, half-width pallets, or special pallets. These findings do bear out the fact that 72 percent of all-freight flights were made by narrow-body jets, not capable of handling the M1 or M2 container [4:408]. It is assumed that these percentages have shifted since then due to the acquisition of approximately fifteen more B747F's by domestic air carriers.

C. COSTS

The cost effectiveness of a container, whether for surface or air, is possibly the most problematic of all containerization concepts. It is problematic because even with the greater efficiency afforded by the container, the container is quite expensive.

The container itself, due to light weight requirements for air travel (materials such as balsa, fiberboard and styrofoam are used) and the structural strength requirements that have been set by the International Standards Organization (ISO) (materials such as corrugated or reinforced aluminum are used to sandwich the lighter products), has costs approaching $9,000 (see Exhibit 3) each for a six meter container. The difficulty is convincing the airlines to buy these more expensive containers, when an argument can be made to purchase cheaper surface containers which cost approximately $2,500 each for the same size container.

Since surface container total costs are lower, it is logical to use them. However, the added weight of the container (4500 pounds for a surface container in comparison to 2200 pounds for an air container), plus the additional requirement to use a 1400 pound flat pallet on the surface container because air container bottoms must be flat, severely hampers maximum utilization of aircraft space and weight. This is not cost effective, either on a total distribution cost basis or single trip basis [19:9].

Exhibit 3 depicts a representative air intermodal container which cost \$8500. When this container is compared to a typical 6 meter and 12 meter surface containers (as shown in Table IV), a trade-off must be made to lower total distribution costs before decisions can be made about new air container acquisitions.

TABLE IV

RELATIVE COSTS OF CONTAINERS

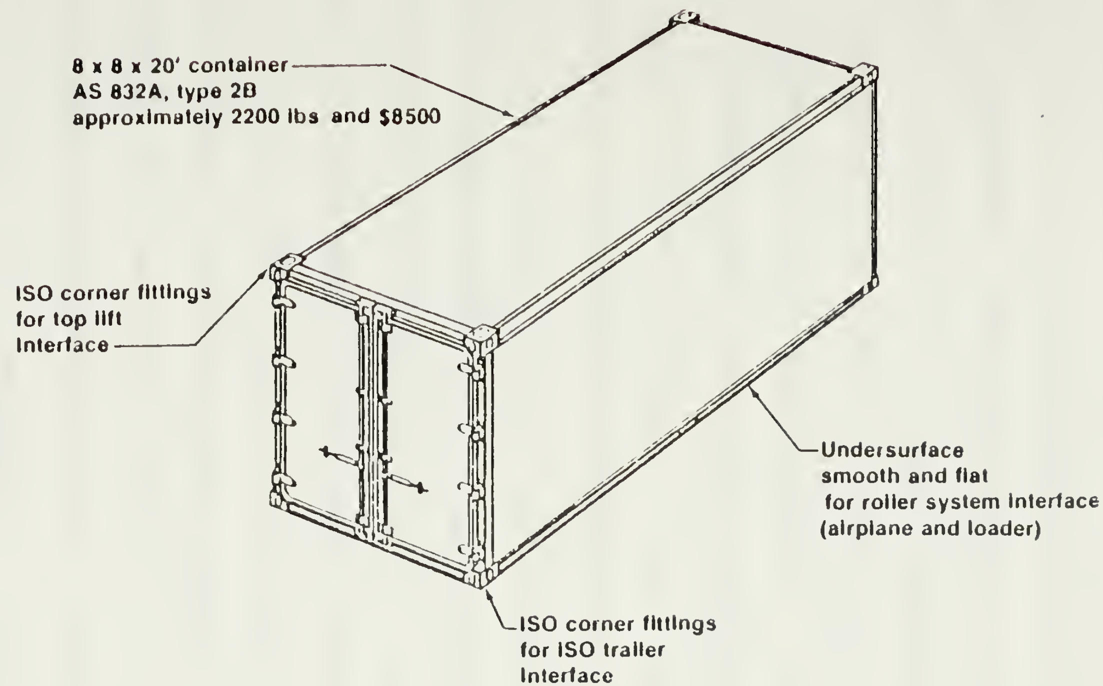
TYPE	AVERAGE COST
6 meter intermodal (air)	\$8500
6 meter surface	\$2600
12 meter surface	\$4100

Source: 6 meter and 12 meter surface prices obtained from Director of Public Relations, Container Transport International (CTI), and represents industry averages, May 1979.

Considering the much larger capital investment (over $3\frac{1}{2}$ times) in air intermodal containers and a nearly one-half reduction in allowable cargo weight (22885 pounds as compared to 39550 pounds) per container, the cost of air intermodal containers, when viewed alone, seems prohibitive.

However, when costs such as handling, pilferage, damage, inventory loss and the like are considered these costs offset one another, when compared to the total investment. Another cost item is the material handling equipment (MHE). Each airline that handles intermodal containers has a need for \$100,000 loaders and other auxiliary equipment. Since at least two are required at each air terminal, insuring a back-up is available, the capital investment for MHE is

Container



Source: Intermodal Air Freight System Progress Report,
Boeing Commercial Airplane Company,
Air Freight Systems Office, Seattle, March 1979.

EXHIBIT 3

high [19:9]. At present the airlines do not consolidate their needs with joint usage of MHE. They purchase their own equipment, therefore necessitating higher rates for an adequate return on their investment.

There are presently several surface container firms (such as CTI) that have an inventory of six meter air intermodal containers. With this type of commonality present today, growth can occur at a rapid rate. The total number of containers is small in comparison to the surface modes, but expansion has been excellent. The airlines, due to capital considerations, have also discarded the notion that they _must_ own the containers, rather than lease them.

The pooling of containers through leasing corporations has demonstrated to the airlines that reduction in costs can be achieved when large numbers are involved. If the leasing corporation can purchase more air intermodal containers due to high demand by airlines, leasing rates can be reduced, and the airlines could in turn pass on lower shipping rates. This concept is an excellent example of minimization of costs through the use of an integrated system. An integrated system, one agreed to by all carriers as in the surface mode, would reduce redundancy of effort and duplication of investments. The pooling of containers is but a small part of the airlines overall effort to eliminate duplication and reduce costs. These are of course problems that must be dealt with due to the small amount of freight

carried by air, but fortunately, these problems are beginning to be analyzed on a systems level, with an eye towards an integrated solution.

Maintenance costs on intermodal containers at the present time appear illusive. The reasons are:

1. Most airlines do their own maintenance and do not keep close control on hours spent in this activity.

2. Surface-type container repair facilities know that air containers cost roughly 3-5 times that of sea containers, so repair rates are scaled accordingly.

3. A total loss (no salvage available) figure does not exist, but is accepted as $5400.

4. The economics of container repair is not fully understood for intermodal types. [20:12]

These problems are beginning to be corrected as more airlines turn over their repair work to outside facilities. As these facilities become more knowledgeable in air container repair, it is reasonable to conclude that they will better understand the techniques involved, and be able to obtain a more accurate estimate of costs.

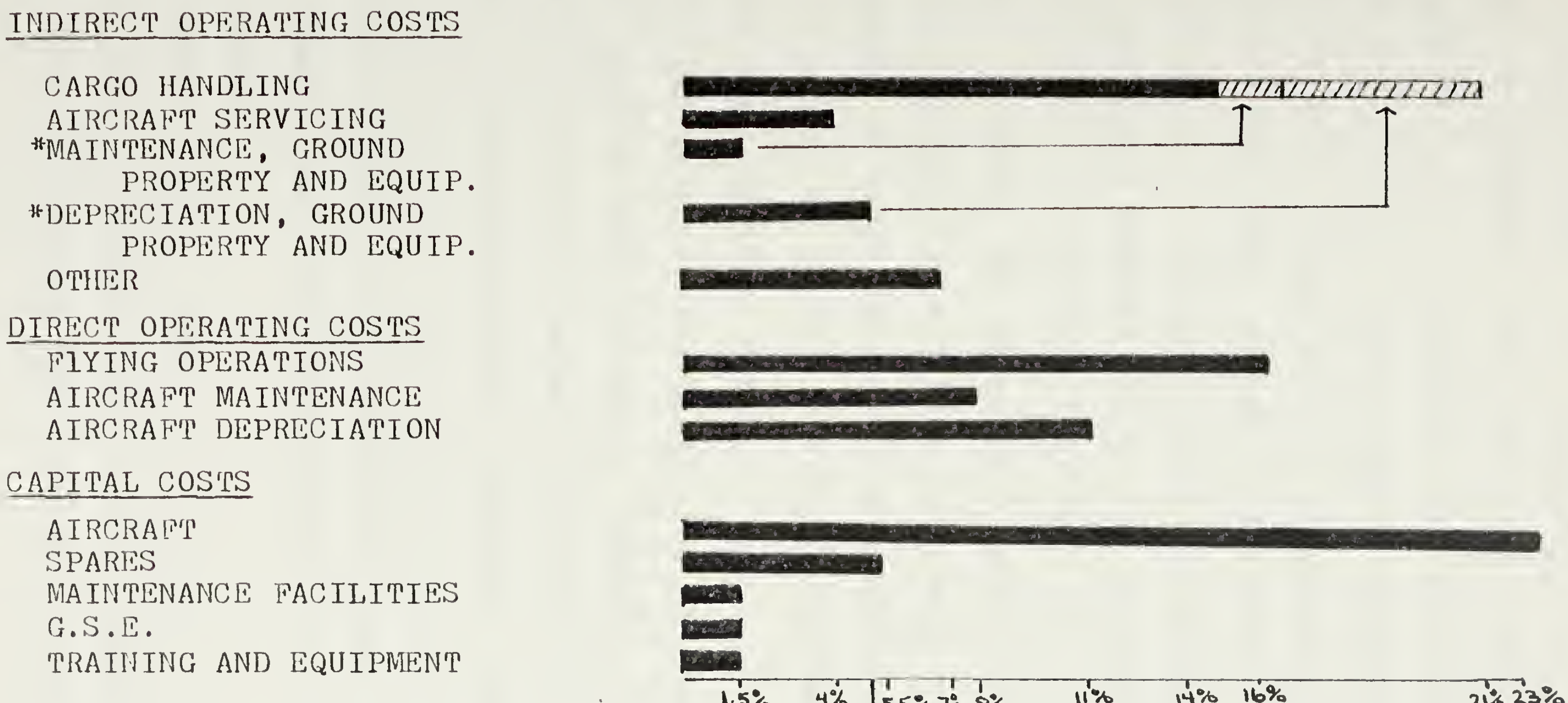
There is another topic deserving of mention, since it is possibly the largest controlling influence on cargo operations, and that is total cost. It should be noted in Table V that indirect operating costs are quite large in comparison to direct operating costs. The surface modes of transportation are more able to control their indirect operating costs, which necessarily result in lower shipping

charges [17:3]. Until these indirect operating costs can be brought in line on a comparable scale with indirect operating costs of surface carriers, the air cargo industry is going to be hard pressed to compete on a volume basis with the surface modes.

These total costs may be reduced by a cutback in cargo handling and flying operation expenditures due to higher and faster throughput, and less loss and pilferage of cargo by using containers. These reduced costs would be offset by increased capital investments and depreciation. A complete feasibility study appears necessary to determine the trade-off between present operations and projected container operations.

TABLE V

TOTAL COSTS



*Costs associated with cargo handling

Source: Norman, J. M., Integrated Surface-Air Transportation, Fourth Annual Intersociety Conference on Transportation held at Los Angeles, Calif. ASME, New York, 1976.

D. AIRCRAFT COMPATIBILITY AND TRENDS

The M1 and M2 intermodal containers are compatible only with wide-body jets. The Boeing 747F is the only aircraft capable of handling 2.44x2.44 meter containers two abreast. The Douglas DC-10, Lockheed L-1011 and Airbus A300 can handle one lane of 2.44x2.44 meter containers with the remaining space being taken up by pallets. The wide-body jets are also capable of handling surface containers, as well as pallets. Though surface containers must be attached to a 1400 pound adapter pallet for aircraft loading, this does not prevent nose loading of B747F's due to the additional height. However, the extra 1400 pounds for the pallet and the 5,250 pounds in container tare weight obviously reduces the amount of cargo carried, and therefore a high priority must be placed on surface container shipment by air to justify the additional cost.

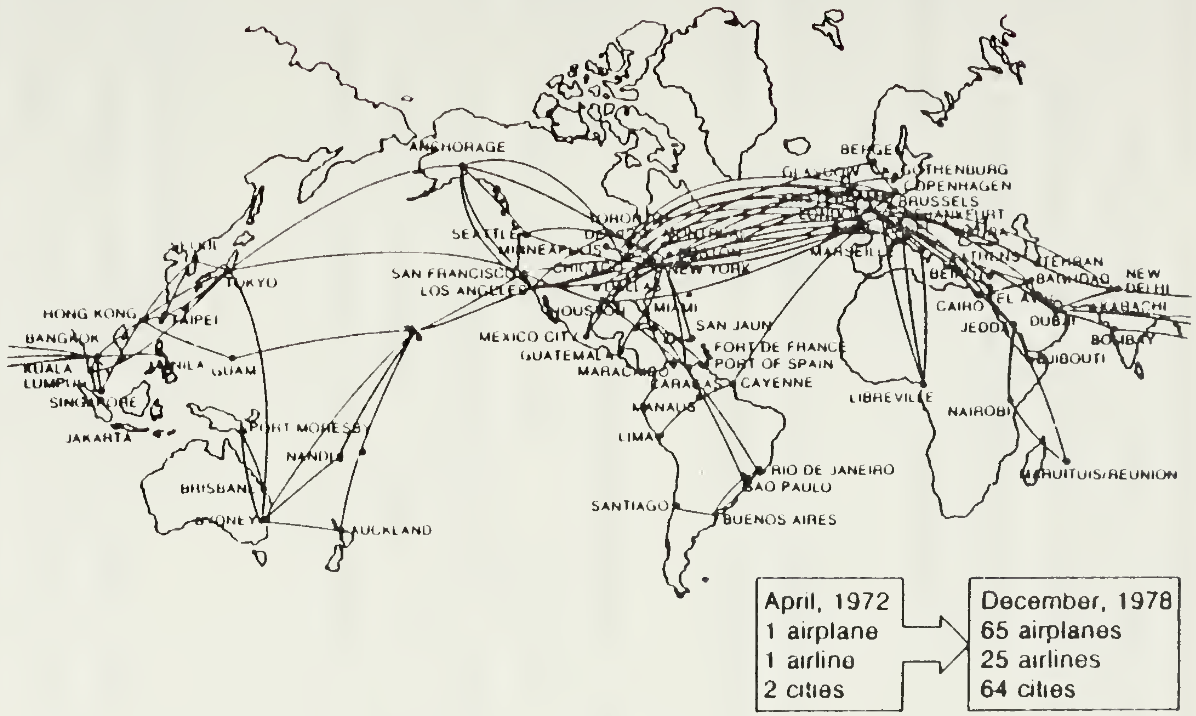
Aircraft such as the Boeing 707 and Douglas DC-8 are widely used as cargo aircraft. Neither of these is capable of handling 2.44x2.44 meter type containers, but both are capable of carrying smaller containers, igloos, and pallets. The vast majority of these smaller aircraft, and their associated compatible containers and pallets, is one of the main reasons that container growth has not proceeded at a faster rate.

However, cargo carriers are opting for wide-body jets (especially the Boeing 747F) as new purchases when their older 707's and DC-8's reach the end of their useful lives,

and this trend is influencing the increased need for more intermodal containers. This fact is born out by Exhibit 4. In the past six years the number of B747F's has increased from one to sixty-five, and the carriers who own these aircraft have attempted to only handle unitized containerized cargo at all times. To do otherwise with a large aircraft would keep the plane on the ground longer and, thereby, insure inefficient use.

Basically, 2.44x2.44 meter type intermodal containers are most effective with wide-body jets, and as more of these jets are purchased with a resulting decrease in the narrow-body jet population, there will be an even greater demand for containers to effect rapid turn-around time for these very expensive aircraft.

747 Main Deck Cargo Service 1978



Source: Intermodal Air Freight System Progress Report, Boeing Commercial Airplane Company, Air Freight Systems Office, Seattle, March 1979.

EXHIBIT 4

V. PRESENT MILITARY CONTAINER USAGE

Containerization in the military arena should be prefaced with a discussion of military containerization policy. The Department of Defense (DOD) has repeated strongly its advocacy of containerization.

1. Military cargo will be containerized for transportation whenever possible.

2. DOD will rely primarily on container resources/services furnished by the commercial transportation industry.

3. Development of a container-oriented logistics system is a matter of priority DOD wide. [15:15]

It should be noted that regardless of DOD policy, the military is basically container barren, and relies almost solely on the 463L materials handling system for air cargo movement.

A. 463L MATERIALS HANDLING SYSTEM

The 463L system consists of the basic unit, a 2.74x2.23 meter pallet made of aluminum and balsa wood in a sandwich type construction, and webbed restraint nets. These pallets have restraint lips designed to be compatible with the guide rails and restraint mechanisms installed in military aircraft such as the C-141 and C-5A [25:1]. This aircraft internal restraint system consists of roller conveyors, external

guides, locking rails and many tie down rings. The function of the system is to help guide the pallets into the aircraft, and then secure the pallet in the desired position. The C-130 can accommodate five 463L pallets; however, this aircraft is not configured with the 463L internal handling or restraint system, and is more time consuming to load. The C-141 can accommodate up to ten pallets, and the C-5A can accommodate up to thirty-six pallets in two rows [14:3, 9,24]. The 463L system is completed by the ground handling equipment. This equipment consists mainly of 25,000 pound and 40,000 pound loaders as shown in Appendix B-1 and B-2, 4,000 pound forklifts (which replace the 4,000 pound trucks) as shown in Appendix B-3, staging rollerized equipment, and their associated warehouses. This handling equipment, which is located at all major Air Force bases, is an Air Force controlled system since the Air Force is the single manager for all military cargo airlift.

There are some problems associated with this system, even though it still functions well. The 25K and 40K loaders are beginning to show their age through increased maintenance requirements. Further, although a 40K loader with its five pallet limit is useful for loading a C-141 with a ten pallet maximum, it is inefficient in that it takes an unreasonable amount of time to load a C-5A with a thirty-six pallet capacity. Changes in loading equipment and or procedures are needed for the C-5A assuming the Air Force retains the 463L system. The amount of manpower that must be expended

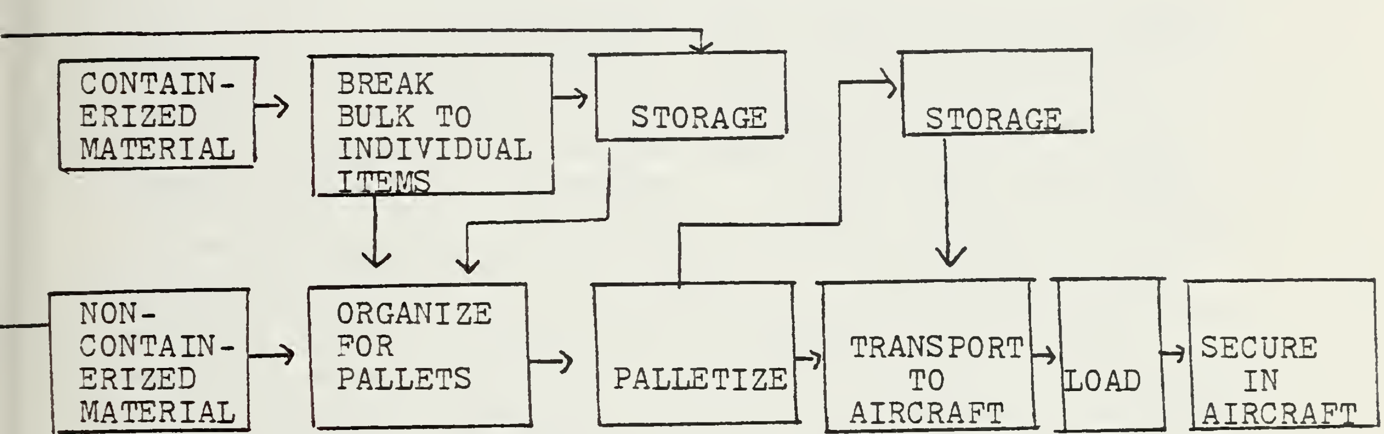
to load and unload aircraft is excessive. Further, this manpower would not be available in a crisis situation due to recent cutbacks by Air Force bases, which have already resulted in backlogs of cargo [18].

The 463L system is also basically an Aerial Port of Entry (APOE) to Aerial Port of Departure (APOD) operation. The system was designed for break-bulk input to the warehouse for pallet buildup, shipment, and break-bulk teardown at the destination. This is inefficient because of the large amounts of time needed to handle packages individually. The closer the break-bulk operation gets to the consignor and the consignee, the more efficient the operation becomes. This problem has been addressed through a joint Air Force - Army program called Air Lines of Communications (ALOC). The Army (shipper) builds pallets at its shipping points, and delivers the pallets to the Air Force. The Air Force loads, transports and unloads the complete pallets at the APOD, and the Army picks up the pallets for transfer to their final destinations. This program is not "intermodal", but is a consignor to consignee operation which is necessary to make containers viable, or for that matter, make the military air cargo system viable. As far as the Air Force is concerned, these pallets are containers since the Air Force serves only as the carrier of this unitized load, and does not keep track of individual pieces. Initial indications were that this joint program greatly reduced shipping time, mainly due to the elimination of break-bulk handling at the APOE and APOD.

It is imperative at this point to make some comparisons of the 463L system and containers. Exhibit 5 shows the basic flow involved in loading an aircraft with these pallets, and will be compared later with the flow of containers.

EXHIBIT 5

AIR CARGO FLOW WITH PALLETS



This exhibit assists the reader in understanding the basic facets of the process used at Travis Air Force Base, which is representative of all Air Force bases. In this process, if material enters military cargo jurisdiction in containers, extra work is required to break down the containers for palletization. This process itself creates duplication of effort. The organizing for palletizing and the palletizing process itself creates additional work, and further slows down the processing of the material. From this point, however, the process is relatively efficient, for pallets are handled as units. They are retrieved from the palletizing area, moved to the aircraft and loaded.

The loading process is efficient, with the exception (see page 42) of the C-5A, in that the decks of all aircraft (C-130, C-141 and C-5A) have rollers, and the pallets can easily be moved into place by two men and secured.

It has conclusively been demonstrated in the sea-cargo movement arena that containerization, in-and-of-itself, reduces costs.

> This switch to containerized cargo resulted in increased capital costs for equipment, new ships and loaders, and therefore, increased interest and depreciation costs. Overall, it is estimated that investment approximately doubled; however, the reduced manpower resulted in an overall savings of 10 percent. In port, time decreased considerably from 7 days for a break-bulk ship to 22 hours for an equivalent containership. Other indirect costs included a reduction by 50 percent of breakage through containerization. Pilferage is negligible via containers compared to an average 10 to 15 percent loss via conventional mode. The lower loss rates can be attributed to a reduction in handling of 2 to 8 times compared to break-bulk shipments, depending on the origin and destination of the containers [25:6].

Some of the points mentioned above highlight the military dilemma, even though it describes the conclusions reached about sea containers in 1958. The government airlift system presently experiences a similar pilferage and breaking rate [18]. A larger labor force is required to accomplish the break-bulk process, as well as organizing the material for palletizing and the palletizing itself. It has already been mentioned that the necessary labor force is not available. Further, the breakdown of containerized materials is an additional step in the material handling process, a step that adds to the probability of pilferage or breakage.

In addition, the problems experienced by the commercial shipping companies of increased wages and the necessity to reduce total costs to remain competitive impinge directly on the military air cargo shipment process. Within the last ten years, military and government employee wages in general have drastically increased in relation to total outlays, creating a large direct labor cost in handling material.

It appears reasonable to assume that if the front end of this material handling process, from receipt to palletization, is allowed to continue, the military will continue to spend excessive amounts of money and time handling break-bulk shipments, contending with pilferage and breakage, and providing less than desirable service. An attempt has been made to alleviate some of these problems with ALOC, but ALOC constitutes only a small part of Air Force cargo movement. These problems will be further compounded if civilian container growth matches projections. If it does, the military will have to contend with an ever-increasing number of containers to be broken-down for palletization. More importantly, providing less than required service may equate to loosing a battle, if not a war.

However, one must closely compare the benefits gained by container unitizing loads against the system of the 463L pallet. It appears that the cost would be prohibitive to scrap the 463L system for a container system. The Air Force presently operates C-130's, C-141's and C-5A's all configured

to handle the 463L pallet, and these pallets can be loaded quickly, with the exception of the C-5A. The cost alone to "back-fit" these aircraft to accommodate containers appears prohibitive.

It must also be considered that the military airlift of cargo accounts for only about five percent of total military cargo movements. This further enhances the argument that the present system should be maintained, using containerized movement secondarily in air shipment. It is also true that present 463L pallet handling equipment is incompatible with intermodal containers, or MILVANS, and any military container program of reasonable dimension would necessitate the acquisition of different handling equipment. Appendix C shows an adapter pallet for use with surface type containers. This has been the military's method of addressing the container interface, but it does not address the lightweight intermodal container.

At this juncture, there is an impasse. However, several other concepts must still be considered, namely, packing density, total system efficiency and military goals.

The packing density of a 463L pallet is good, but the space the pallet takes up in the aircraft is generally small. There are massive amounts of unused and available cargo carrying volume. The 463L system has better volume and load factors when used with the C-130 and C-141 aircraft, but these factors are not optimal by any means.

The 463L system, though considered relatively efficient by many, appears to be showing its weaknesses. In comparison to container traffic, it lends itself to higher pilferage and breakage, as previously mentioned, and limits the ability of a commander at a remote outpost to receive shipments of materials in a timely fashion. It is mentioned here in regard to immediate delivery at the beginning of a conflict, for certainly, massive amounts of material to support a war effort would be transported by sea or land.

Further, in case of a major conflict, wide-body commercial jet liners would be summoned to help in material movement. The interface problems would be compounded by relatively overall inefficiencies of the pallet system in comparison to the ever growing intermodal container market in commercial air cargo shipment. A conflict is certainly not the time to begin attempting standardization.

As a concluding remark about the 463L pallet, a close look must be taken at the goal of the system, and how it relates to the goals of the military defense force. The aircraft and pallet system operate under the premise of providing air base point to point delivery and air drop services. With the supplier to customer intermodal service now available commercial wide, should not the military strive toward the same goal? It is feasible, but is it cost effective? These questions will be considered after a full discussion and comparison of the container question has been undertaken, and a description of the Civil Reserve Air Fleet (CRAF) has been provided.

B. CIVIL RESERVE AIR FLEET

The Civil Reserve Air Fleet (CRAF) cannot be fully understood without a knowledge of the total strength of U.S. cargo air lift capacity, both civilian and military. Therefore, a digression is needed to compare military and civilian assets.

The Military Airlift Command (MAC) has a large number of aircraft at its disposal for military cargo airlift. Such aircraft as the C-9, C-135 and C-137, as well as smaller trainers and helicopters are included in its inventory. The Air Force Reserve also has older aircraft such as the C-123 and C-7 that can be activated in fairly short order. The Naval Air Reserve has a number of C-118's that can be activated rapidly. However, the bulk of MAC air cargo capacity consists of the C-130, C-141 and C-5A, inventory quantities of which are shown in Table VI.

TABLE VI

AIRCRAFT TYPE	QUANTITY AS OF 1 JAN 1979	MAXIMUM PAYLOAD TONS	RANGE AT MAX. PAYLOAD NAUTICAL MILES
C-130	311	22	2420
C-141	270	44.5	3500
C-5A	76	132.5	2950

Sources: Defense Transportation Journal, Volume 35, Number 1, Feb. 1979, p. 46. Payload and range information: Janes' All the Worlds' Aircraft, 1978-1979.

These three aircraft provide a total lift capacity of about 29,000 tons, at maximum range. Of course, longer ranges can be achieved with these aircraft if cargo loads are decreased, or maximum payload carried can be increased if inflight refueling is provided for extended ranges. These figures give estimated single trip airlift capabilities only, and the total single trip military lift capability is approximately 50,000 tons when all military cargo aircraft are used. These figures indicate that these three aircraft are the workhorses of the military airlift community.

The Air Force is continuing the C-5A wing modification at a cost of over $1 billion. This program is absolutely necessary to sustain the ability of MAC to perform its mission, since the C-5A represents about 50 percent of its military airlift capability. This wing modification is being done to correct design problems found in the wing attachment to the fuselage. The C-141 is scheduled to be "stretched" to provide a 30 percent increase in cargo capacity. This program is expected to cost about $600 million and will increase cargo single-trip payload for the fleet of C-141's by about 3,600 tons, or 13,35 tons/aircraft. All indications point to the fact that MAC will need every bit of capacity it can obtain [16:II-B-8]. For comparison, Table VII presents current CRAF allocations, as of 1 Feb. 1979.

TABLE VII

			TOTALS
DOMESTIC SEGMENT			
DC-9-30	3		
L-188	26		
L-100-30	12		41
ALASKAN SEGMENT			
B-737	5		
C-46	2		
L-188	1		8
SHORT RANGE INTERNATIONAL SEGMENT			
B-727	46		46
LONG RANGE INTERNATIONAL SEGMENT	Passenger	Cargo	
B-707	92	12	
DC-8	20	65	
B-747	93	22	
DC-10	51	14	
L-1011	6	0	
	262	113	
			375
Total Aircraft			471

Source: Defense Transportation Journal, Volume 35, Number 1, Feb. 1979, p. 46.

This massive reserve airlift capability has been growing for the last 25 years, and when first conceived, was to augment the strategic lift capacity of MAC. CRAF has today become an equal member, so to speak, providing half of the USAF's long-range capability during contingencies. However, even with this massive airlift potential, studies continue to indicate it is not sufficient, mainly due to outsize cargo such as the M-60 tank [16:II-B-6].

CRAF is presently in a transitional period. Various member airlines of CRAF such as Seaboard World, Flying

Tiger, United, Pan American and American have agreed to purchase aircraft in cargo modified configurations (the programs are referred to as full-mod and mini-mod) that will provide the best overall capability in time of need. The purchases are being partially offset by the government to encourage the airlines to participate in CRAF. This program is generally known as the CRAF Enhancement Program, and is designed to produce either pure cargo or convertible aircraft that meet the needs of MAC if required [22:50].

This program has drawn to it these carriers that are international carriers or at least long-haul carriers, and those that were scheduling wide-body purchases regardless of CRAF. For the carriers already planning to operate air cargo freighters, the CRAF Enhancement Program has acted as a subsidy for their equipment acquisition costs.

This program has projected conversion costs of $570 million in 1978 dollars [22:55]. However, it should be noted that at the same time the federal government is, 1) providing consent and approval of air cargo systems, albeit modified to meet military needs, that are structured around a growing container influence, and 2) is supporting a military air cargo system that is basically incompatible with the civilian systems. That is, CRAF is at the zenith of available technology, utilizing the most current techniques in cargo handling and dispatching, while MAC is still using equipment that was conceptualized in the late 40's and put into action in the late 50's.

Considering the fact that:

1) CRAF operators are in business for profit.

2) Profit making organizations do not undertake ventures unless a reasonable risk is present, and a reasonable return on their investment is likely.

3) Profit making organizations use new technology to attract a larger share of the market population.

4) Profit making organizations either provide the service advertised, or no longer exist.

It is only reasonable that MAC, and DOD as well as Congress, should not be looking towards a temporary fix of a 1950's cargo handling system within MAC but should rather be looking at the possibility, whatever the cost, of becoming compatible with CRAF commercial-type operations. The "patching" of an outdated system, with its inherent cost savings, may spell disaster when compatibility and mission effectiveness are subservient to various costing techniques that sub-optimize the military air logistics network.

C. PHYSICAL CHARACTERISTICS

The military, unlike the civilian community, has only a small number of containers. This is a result of the usage of the 463L system for air cargo, and the lack of containership usage for surface cargo. A small number of random-size containers is included in the military inventory, but these are not controlled or used in the same manner as commercial containers. These small containers resemble igloos or LD's,

but they are not a pre-planned, integrated unit of an overall logistics system.

Military Vans (MILVANS) are the only containers in the military inventory that have been procured as an integral part of the military logistics network. There are two basic types of MILVANS. The basic form of the MILVAN is a 2.44x2.44x6 meter box, of good strength and of similar construction to the commercial surface container. Appendix D-1 shows an interior view of a MILVAN with pertinent data listed. A modification has been made to this basic container for transport of ammunition. An interior view and pertinent data are presented for this modification in Appendix D-2; note that the basic difference between the two containers is an additional 1300 pounds of tare weight due to the ammunition restraint system. The other form of the MILVAN is the refrigerated type. This container is shown in Appendix D-3, and is basically the same construction, but with added weight for a generator and ancillary equipment to perform the refrigeration function.

As of this writing, there were 6510 MILVANS of the conventional and ammunition handling type in the inventory. There has been no plan to procure additional regular MILVANS, but a procurement of over 5000 ammunition restraint containers is planned in the 1983-1984 time frame [8:I-1, I-5]. The refrigerated MILVAN is only now coming into the military inventory, with initial acquisition having begun in February of 1979 and having a projected delivery of fifty units in 1979. Total acquisition is planned for 948 units [8:I-6].

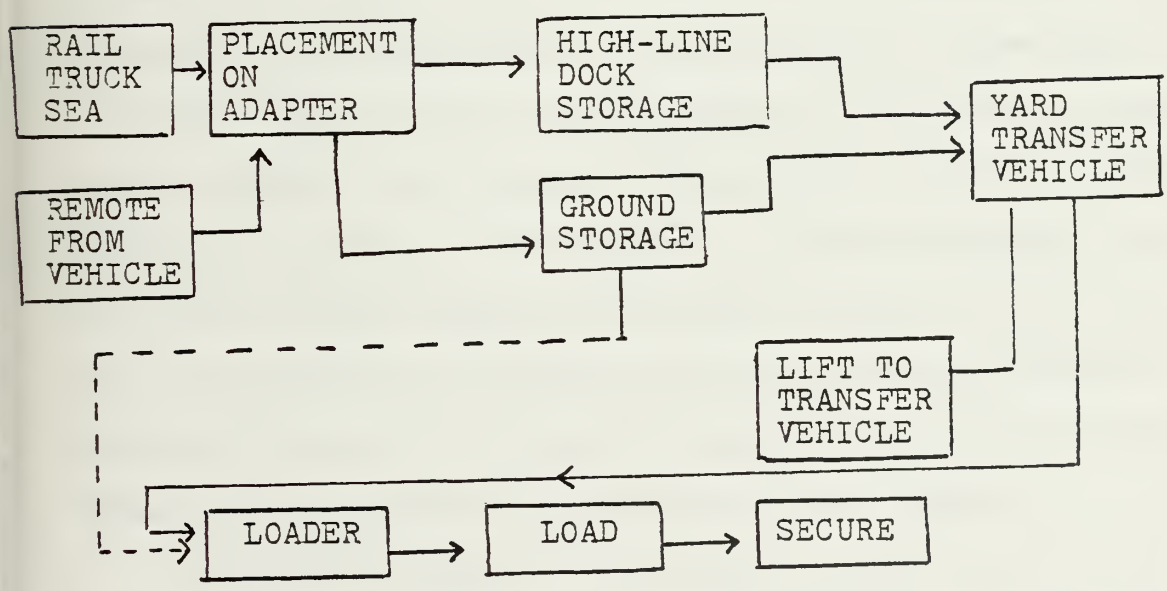
D. EMPLOYMENT AND UTILIZATION

The MILVAN is generally used for shipment of small piece cargo and ammunition. Though an adapter pallet is available to make the MILVAN compatible with the military air mode, it is seldom used because of the weight penalty involved. What follows is an analysis of the MILVAN as it relates to the air mode.

it is obvious that the MILVAN was not designed for air use, because of its high weight. The fact that it is extremely inefficient when used for air cargo handling is summarized in Exhibit 6 for loading operations.

EXHIBIT 6

AIR CARGO FLOW WITH MILVANS



Adapted from [24:20]

Assuming a MILVAN or comparable 2.44x2.44x6 meter commercial container is the input, two severe inefficiencies become readily apparent. The placement of the container on an adapter to interface with the 463L compatible aircraft system is time consuming, and adds an extra 1400 pounds of unwanted weight. The adapter is absolutely necessary with MILVANS to provide a flat bottom surface, and to prevent corner point overload of deck area in the aircraft as presented by the bottom corners of MILVANS [25:34].

Another problem inherent in the air use of MILVANS is the capacity of current loading equipment. With a 44,800 pound gross weight of MILVANS, the predominance of 40,000 (40K) pound and 25,000(25K) pound loaders makes it apparent that not all equipment can handle the MILVAN. There is some movement to acquire more container handling equipment; however, this procurement is proceeding at a slow pace and could not keep up with CRAF aircraft if employed for massive cargo movement in a crisis. None of the present military handling equipment, for example, is able to achieve the 16-18 foot deck height required to load a Boeing 747F [25:19]. This problem will be reduced when the equipment shown in Appendix E-1, E-2, E-3 and E-4 are acquired, but as indicated, these are considered long-lead time procurements.

The present method of loading containers in military aircraft, in and of itself, wastes time. Container line-up with the aircraft does not always happen on the first attempt. This is due to current methods, which require exact match-up of the load to the aircraft rail system,

and will be corrected with the acquisition of the new handling equipment.

Time is also wasted in securing cargo. Since military aircraft are configured for ease in securing the 463L pallet, changes must be made to properly secure a container. Again, more time is required. Naturally, these steps require additional people, and with the ever-increasing wage costs, in relation to total government outlays, occurring for military and civilian government employees, these costs are escalating.

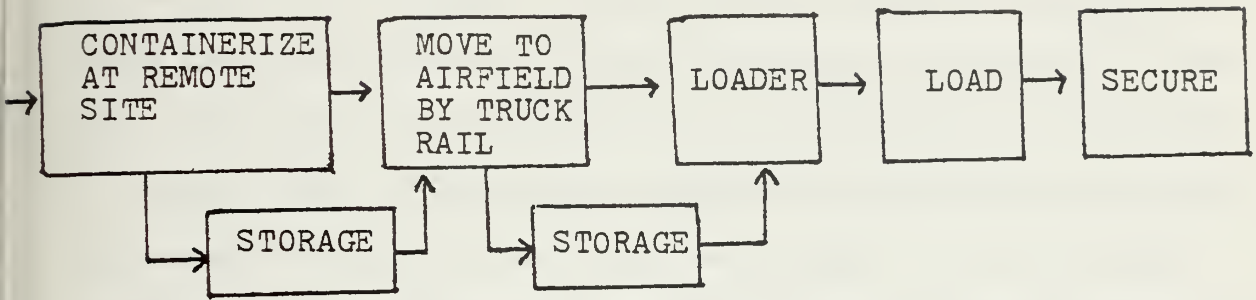
It is also apparent that existing military aircraft which was designed to accommodate the 463L pallet, incur large expenditures in time, money and lost military effectiveness when used to transport containers. It also appears that movement is afoot to design different types of containers, which have no relationship to the containers on the commercial market. An example of this is illustrated in Appendix E-5, a container insert, which is basically not compatible with anything available except the MILVAN.

The intermodal container, unlike the 463L pallet and MILVAN, has an extremely short history, but it is already part of the civilian air distribution network.

Exhibit 7 is presented for comparison with the flow diagrams of the 463L pallet and MILVAN.

EXHIBIT 7

AIR CARGO FLOW WITH INTERMODAL CONTAINERS



It should be evident that this system is somewhat less cumbersome. The flow process is extremely simplified, with no necessity to attach adapter pallets. The high efficiency at the load site is realized due to containerization at the point of origination.

Assuming the necessity is eliminated to manually rearrange deck runners, massive amounts of wasted labor hours, time, and ancilliary equipment are eliminated. The material is packaged once at the origination point, and unpacked at the receiving point. This process flow eliminates the repackaging inherent in pallets, and eliminates the need for adapter pallets associated with the MILVAN.

Furthermore, the intermodal container is fully intermodal. It can be accommodated by air-sea-truck or rail vehicles, and it is standardized and meets international requirements, as well as being in inventory (or on lease) and in use by major commercial cargo carriers. The container comes in lengths of 10' and 20'; and for the 20' container, it has a weight nearly 2000 pounds less than a MILVAN. This reduced weight makes it extremely efficient for air use.

The intermodal container, of course, has all the advantages of the MILVAN relating to packing density, cubic utilization, pilferage and breakage. It also has a superior ability to withstand corrosion due to its non-ferrous materials. Overall, this unit is far superior to the 463L pallet or MILVAN to effect fast, reliable and quality transportation services, and cannot be matched in weight advantage. It is in production, most technological difficulties have been corrected, and is fully compatible with all occidental modes of shipment, as well as most international carrier cargo systems.

There appears to be some reluctance at the military planning level to come to grips with intermodalism, and the need for compatibility with the commercial air cargo industry. Perhaps this conclusion is too hasty; however, the military tends toward a "redesign of the wheel" approach rather than a productive use of good, current technology being utilized by profit oriented corporations.

Not to appear too pessimistic, it must be noted that the military air cargo community has at least realized the obvious efficiencies in containerization. The MILVAN realizes higher stuffing efficiencies, particularly the 6 meter container, and even when an adapter pallet is used, has a somewhat comparable load efficiency with that of the 463L pallet. The container provides the advantages of less pilferage and the other benefits that are inherent in containers.

The extra time required to prepare the interior deck area of military aircraft and to place an adapter on a container is shorter than the time required to break down a container, sort and palletize its cargo.

The military appears to be moving in the right direction, but the direction is necessarily controlled and limited by available funds. Therefore, it is imperative that the funds be used wisely. With the burgeoning use of intermodal containers on the commercial scene, it does not appear that resources are being best utilized for efficient management of air cargo transport. This statement can be justified because of the following facts:

1) In case of a conflict, extreme problems would be encountered in using commercial aircraft for military use.

2) A joint service plan is not available for the replacement of older MHE with newer MHE for the movement of pallets, as well as containers.

3) A concerted effort is not evident to provide policy concerning direction of the military container effort as it relates to compatibility with the civilian container community.

4) Time wastage and military effectiveness are not given due regard when analyzing trade-offs between palletization and containerization, but languishes in World War II concepts of break-bulk cargo.

5) Analysis has traditionally been done piecemeal (Air Force separately, Navy separately, et cetera), rather than as an overall systems analysis for DOD.

These problems necessarily result in a small use of containers for military air cargo movement. The military forces have not made a concerted effort to use MILVANS for air cargo, and have made little progress, if any, towards the use of commercial air intermodal containers. An apt quote is made here about sealift, which also is directly relatable to airlift.

> Containerization is now a way of life and we must learn how to live with it and obtain the most from it. We must learn to benefit from the advantages offered by the container, to outweigh , if you will, the problems. We cannot utilize containers for our peace time sealift requirements and expect to revert to a break-bulk operation in a contingency, nor can we cling to break-bulk methods now, hoping we won't need to use containers in an emergency. We as planners must adjust our thinking to the container and revise our planning factors accordingly... The policy decision to use commercial containers for most DOD shipments has already been made. [refering to sealift] It is more appropriate to utilize this existing civilian commercial capability than to procure our own. We have many other uses for the available funding [10:II-N-5, II-N-11].

E. COSTS

Cost data, as they relate to military hardware, are probably some of the most difficult items to "pin-down" when describing material that has been in the inventory for an extended time. Therefore, some of the cost information presented here is a "best guess" by those considered knowledgeable in the field.

The MILVAN is estimated to have a unit replacement cost of $5300, and generally exceeds sea-land container prices on a ratio of 2:1 due to military specifications (MILSPECS) [22]. It is interesting to note that inflation has taken its toll here, as in all other facets of life. The general

cargo MILVAN's were procured in June 1970 at a unit cost of $1225 [8:I-5]. These figures indicate an inflation rate for MILVAN's of about 17.7 percent/year.

The MILVAN configured for ammunition restraint costs about 20 percent more than a conventional MILVAN due to the increased tare weight. Presently, 4324 MILVAN ammunition restraint containers are in inventory, with procurement scheduled for 5097 additional units in fiscal years 83-84 [8:I-1]. This information, coupled with the above cost data, can be used to generate an estimated cost for this procurement.

$5300 + 20%($5300) =	$6360 per unit
17.7% inflation rate/year	
Projected unit cost(((6360x1.177)1.77)1.77)1.77	$12,205.71
total procurement=($12,205.71)(5097)=	$62,212,503.87

Considering that this really is a small procurement when comparison is made with the procurements made by commercial leasing corporations (refer to Exhibit 1), the military is most likely paying premium prices for small orders rather than obtaining low unit costs due to quantity. Furthermore, the military must buy their units here in the United States, while commercial firms are buying or manufacturing their containers overseas where prices are lower.

The refrigerated MILVAN cannot be compared to other MILVAN's due to its special use. The planned unit cost of the container, generator and refrigeration unit is $18,000. The container is of modified commercial design with a MILSPEC. With an authorized procurement of 948 units at a later time, total procurement costs are estimated to be

$17,064,000 in 1979 dollars [8:I-6]. Some negotiations are still in progress for outyear procurement, which is expected to drive up the cost by an unknown amount based on the inflation rate.

Maintenance data were not obtained by the writer on any of the MILVAN's. This information may exist, but it could not be found in any of the reference publications cited, or through phone conversations with military logisticians.

Turning now to military material handling equipment, a look at the equipment in inventory, and then of projected procurements is required. The basic equipments in inventory are the 10,000 pound (10K) forklift, the 25,000 pound (25K) and the 40,000 pound (40K) K loaders. The 10K forklift has a unit replacement cost of $32,848, while the 25K and 40K loaders cost $124,000 and $162,300, respectively [3]. Considering a minimum of thirty major Air Force bases both inside the Continental U.S. (CONUS) and outside (OUTUS), a minimum inventory estimate can be made of $9,574,440 for one unit at each base. However, all of the major bases have at least two units each, and the larger bases, such as Travis, Dover, Hickam, Ramstein, Wright-Patterson, et cetera, have four units each. This at least doubles the population at all bases, and quadrouples the population at one-third of all bases. Using this information, an inventory value of approximately $31,914,800 can be computed. This estimate should be considered low because these figures do not reflect equipment at small Air Force bases.

Making a comparison with the handling equipment scheduled for procurement reveals some interesting facts. The equipment scheduled for procurement, or that which has already been partially procured, is equipment designed to handle both pallets and containers. This provides additional justification to support the need to replace aging equipment (though this is not a one-for-one replacement program) and to be capable of handling containers and the attendant commercial wide-body CRAF aircraft. Some of this new equipment consists of a 4,000 pound (4K) forklift (Appendix B-3), a scissor type loader (Appendix E-1) and a hydraulic type elevator loader (Appendix E-4). The equipment is being procured as shown in the appendices, and does not include Appendix E-2 and E-3 due to inability of obtaining costs. Procurement plans are as follows:

4K: procure 833 units @ $10,120 ea.	$8,429,960
scissor loader: procure 24 units @ $255,000 ea.	$6,120,000
elevator loader: procure 32 units @ $185,000 ea.	$5,920,000
	$20,469,960 [3]

This procurement plan surely demonstrates the military commitment to handle civilian containers moved by commercial wide-body jets, but does not directly address the incompatibility of military air cargo containerization with that in the civilian sector. Though a $20 million expenditure sounds large, this procurement program does not reflect serious thought to wartime contingencies, since more equipment would be necessaryat large bases such as

Travis if a conflict erupted. In addition to the foregoing, 2520 adapter pallets shown in Appendix C are also scheduled to be purchased. The total procurement of 2520 units will cost $5,292,000, and this program also appears austere [23:37]. Since an inventory of approximately 6,500 MILVANS exists, it is reasonable to assume that enough pallets should be available to handle all MILVANS. This does not assume all MILVANS would be airlifted; rather, it provides a possible indicator of how many containers, both military and civilian, might be airlifted in a contingency. Also, since 5,000 more ammunition configured MILVANS are scheduled to be procured, it would seem appropriate to have the capability of airlifting a high percentage of these units, not counting the civilian container requirements.

Lastly, these procurement programs appear to emphasize two separate concepts. One, a pallet to interface MILVANS and sea-type containers with military aircraft and, two, equipment to handle containers and provide the capability to load and offload CRAF aircraft at military air bases. Little emphasis is placed on the handling of intermodal containers in the military system. Rather, the intermodal container is viewed as a civilian product, one for which the military must buy handling equipment to support, and the adapter pallets are viewed as military equipment necessary to integrate surface-type (or MILVAN) containers into the 463L material handling system. It appears that two separate and distinct systems are being generated for military cargo

airlift. The two systems are obviously cost effective, but they do not have the ability to interface (transshipment, rapid load-unload rates and military-CRAF cargo exchange rates are paramount to the combined system effectiveness) with each other.

The remedy of purchasing loaders, adapter pallets, and forklifts has evolved because these costs are much smaller than military aircraft modification costs [21:159]. This handling equipment would have to be purchased regardless of what decisions were made to modify military cargo aircraft. Those opposing aircraft modification make the argument that the cost of the modifications would be prohibitive, as well as not needed, since the CRAF aircraft can handle the container traffic. However, it can also be argued that the relatively low cost programs that have been developed may seriously jeopardize the effectiveness of the overall military air logistics system in times of high volume demand, such as a war.

F. AIRCRAFT COMPATIBILITY AND TRENDS

The compatibility of containers (MILVANS or commercial types) is a matter of well known complacency since there has not been much written addressing the compatibility of containers within the military air cargo system.

The basic problem resides in size differences, with attendant difficulties in the securing mechanisms involved. The 463L pallet is 2.74 m. wide by 2.23 m. long, with the wide dimension being placed in the width of the aircraft. This indicates that, if desired, a 6 meter container could be

placed on three pallets (length 2.23m.x3=6.69m.) with an additional .69 meter to spare. However, it is readily apparent that conducting this sort of operation would leave much to be desired.

This procedure would waste .69 meter of space per every three pallets, and all of the aircraft could not cube out, due to the .69 meters wasted per three pallets, with containers alone; there would have to be pallets mixed with container shipments. Further, although the process of strapping containers to pallets is quite time consuming, until the adapter pallet shown in Appendix C is in inventory, containers must be strapped to 463L pallet trains. As mentioned previously, this adapter pallet is only configured to adapt the ISO container (not the air intermodal) to the 463L aircraft roller system, adds a weight penalty, and, though not as time consuming as strapping containers to pallets, also wastes time.

What is apparent in this analysis is that only the 463L pallet is compatible with military cargo aircraft. The implication here is that while the commercial industry is working to standardize containers and handling equipment on an international basis, the military is working on temporary solutions to a massive logistics problem, that of non-compatibility with civilian commercial aircraft. As the military continues to think "adapter", the military logistics network becomes further separated from the civilian air cargo industry, and continues to design temporary fixes to alleviate

aircraft non-compatibility with containers. As air-type intermodal containers grow in usage, this gap will surely widen.

One other problem of major proportion exists in the area of compatibility. The M-60 and the soon to be obtained XM-1 tank can only be airlifted by the C-5A. This impacts on other airlift requirements, since, if large numbers of tanks are to be airlifted, other military and civilian aircraft will be needed to airlift the bulk of the non-outsized cargo. This would place a further strain on any system that cannot provide rapid turnaround time. A major dependence would fall on CRAF, and, at the present or near future, it is doubtful that the military could satisfactorily handle a deluge of B-747F's with containers. Again, it appears the military is faced with several independent systems that are not tied together in a concerted effort to maximize military airlift, but separated sufficiently to maximize each individual system.

VI. ANALYSIS OF PRESENT CONTAINER USAGE

An attempt at comparing container usage within the civilian and military sectors can be likened to trying to add apples and oranges. The two logistics systems are quite different, operating from a completely different frame of reference. However, a comparison will be attempted to shed light on the interface problems that exist.

A. SIMILAR CONTAINER USAGE

Military and civilian container systems are similar in some of the following respects:

1) The MILVAN and its civilian 6 meter counterpart are almost identical, with the MILVAN being slightly stronger due to MILSPECS.

2) The refrigerated MILVAN is basically a commercial design with slight modification.

3) Projected procurement of container material handling systems are the same.

4) When DC-10 aircraft are used by the Air Force for cargo or personnel, LD units are used for baggage on a lease basis.

Though this listing may not be all inclusive, these are the only points of commonality that merit reflection or consideration, since they represent the major areas of the logistics system.

B. DISSIMILAR CONTAINER USAGE

Military and civilian container systems are different in the following respects:

1) The ammunition MILVAN is much stronger than its civilian counterpart due to the nature of its purpose.

2) Container inserts are at the design and testing level in the military. No consideration is being given to an insert program by the civilian sector.

3) The civilian community is striving to achieve commonality, while the military is planning on keeping the 463L system in operation.

4) The civilian sector is stepping up air container use, and the military is not.

5) The civilian sector containerizes about 80 percent of its air cargo; the military containerizes less than 5 percent of its air cargo.

6) Civilian container stuffing procedures and capabilities are being refined in the air mode, and are essentially non-existent in the military.

7) The civilian sector stresses intermodalism as a concept to be implemented; the military is attempting a "patch" of an existing system.

C. ANALYSIS

There are strong indications that the civilian community is containerizing at a reasonable pace, with the objective of building an intermodal system that will reduce costs, increase

shipment speed, reduce aircraft ground time, give greater customer satisfaction and, of course, be profitable.

The military on the other hand is relying on the 463L Materials Handling System which was designed for break-bulk operation. It has been shown in numerous civilian studies that break-bulk operations when employed with large volume cargo operations lose money, require massive amounts of manpower, and inordinate amounts of time. It has also been shown in numerous studies that the massive outlays necessary to convert to container operations are offset by reduced handling costs, reduced insurance claims due to breakage and pilferage, and reduced labor costs. Containerization provides a perfect example of transitioning from a labor-intensive to a capital-intensive operation, as labor costs rise relative to capital costs.

The military has only scratched the surface with the joint Air Force-Army ALOC program. This small program has reduced ALOC shipment holding times at terminals from about five days to one day, due to the unitized handling of material from consignor to consignee. Until the military changes its concepts about large-scale air cargo operations, and becomes standardized with the civilian community, the armed services will continue to deliver air cargo late, to have high breakage and pilferage rates, to be a labor-intensive operation with not enough cheap labor available, and to not have the capability to truly interface with CRAF on a large scale.

In the past, the 463L system has been considered too "entrenched" to be phased out of the military air cargo system, and also that it would not be cost-effective to replace the 463L system with another. It is the author's contention that, though costly, if the 463L system is not replaced by a civilian compatible air cargo system that relies on unit loads such as the container, and replaced soon, the military air logistics network will be unable to provide the necessary support to the armed services due to low throughput, slow interagency transfer, lack of compatibility with a system that makes up 50 percent of our intercontinental airlift capacity, labor intensive operations that are presently undermanned, and lack of handling equipment. There are more reasons that could be cited, but these are considered to be the most severe. Cost admittedly must be given due consideration, but cost minimization at the expense of support effectiveness can only lead to disaster.

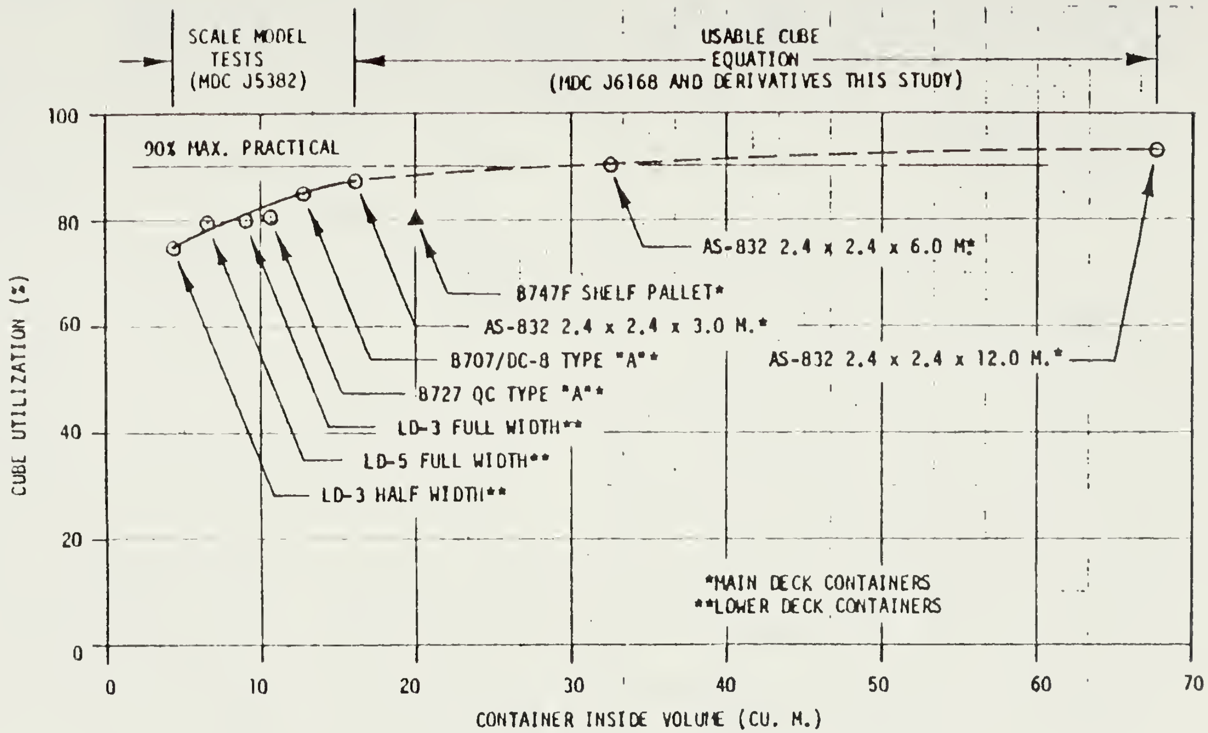
VII. PROJECTED CIVILIAN CONTAINER USAGE

Predicting the number of containers that will be in use in the future is as tenuous as predicting the number of nuclear power plants that will be operating in twenty years. The corollary is that, until the Three Mile Island nuclear disaster, there may have been resistance by some to nuclear power; but, since the disaster, political, economic, socialogical, medical and heretofore unknown factors have created a climate that is not receptive to nuclear power. The same can be said of containers. There are various factors that impact on air cargo, and containers specifically, that could alter any set of projections. However, the projections made here are based on analyses already conducted by McDonnell-Douglas and NASA. It is assumed that these two groups can predict with reasonable accuracy based on valid assumptions and current trends.

A. PHYSICAL CHARACTERISTICS

If one looks at exhibit 8 and 9 on the following pages, certain physical facts become evident.

In the Douglas Aircraft Company Cargo Logistics Airlift Systems Study (CLASS), Volume 3, the models and equations used show that a theoretical maximum cube utilization for a container of 90 percent exists. This is due to the fact that a container will "weigh out' before it 'cubes out'. Exhibit 9 illustrates that this theoretical limit has been



Achievable Maximum Cube Utilization

Source: Cargo Logistics Airlift Systems Study (CLASS), Cross Impact between the 1990 Market and the Air Physical Distribution System, Volume 3, Douglas Aircraft Company, Long Beach, June 1978

EXHIBIT 8

ACHIEVABLE MAXIMUM CONTAINER CAPABILITIES

(1) Container Type	(2) Interior Volume (cu m) (Note 1)	(3) Max Cube Utilization (%) (Note 2)	(4) Max Loaded Density (kg/cu m) 230 9 x(3) (Note 3)	(5) Max Cargo Weight (kg) 230.9x(2)x(3) (Note 3)	(6) Container Tare Wt (kg) (Note 1)	(7) Max. Gross Weight (kg) (5) + (6)	(8) Tare Wt/ Cargo Wt Ratio (6) ÷ (5)	(9) Cont Foot-Print Area (sq m) (Note 4)	(10) Acft Floor Loading (kg/sq m) (7) ÷ (9)
DC-8 Belly	2.10	62.0	143.2	300.6	70.3	370.9	.234	Not Applicable	Not Applicable
LD-3 Half Width (Note 5)	4.39	74.9	172.9	759.2	158.8	918.0	.209	2.40 (3.08)	382.5 (298.1)
LD-5 Full Width	6.54	79 6	183 8	1202.0	272.2	1474.2	.226	4.87	302.7
LD-3 Full Width (Note 5)	9.01	80.0	184.7	1664.3	226.8	1891.1	.136	4.87 (6.23)	388.3 (303.5)
B727 QC Type "A"	10.62	80 6	186 1	1976.4	294.8	2271.2	.149	7.10	319.9
B707/DC-8 Type "A"	12 77	85.0	196.3	2506.3	294.8	2801 1	.118	7.10	394 5
AS-832 2 4x2 4x3 0 M	16.09	87 4	201 8	3247.1	499 0	3746.1	.154	7.29	513.9
B747F Shelf Pallet	19 97	80 0	184 7	3688 9	322 1	4011.0	087	7 74	518 2
AS-832 2 4x2 4x6 0 M (Note 5)	32.57	90.1 (90 0)	208.0 (207 8)	6775.9 (6768.4)	997.9	7773 8 (7766.3)	.147 (.147)	14 77	526 3 (525 8)
AS-832 2 4x2 4x12 0M	67 68	93 0 (90 0)	214.7 (207 8)	14 533 4 (14 064 6)	1896 4	16 429 4 (15 960 6)	130 (135)	29.73	552 6 (536 9)

NOTES
1. From scale model tests (MDC J5382) and/or literature surveys
2. Achievable maximums based on scale model tests (MDC J5382) and usable cube equation (MDC J6168 and derivatives this study)
3. 230 9 kg/cu m from commercial cargo characteristics study (DAC 66616)
4. Parenthetical entries include shadow projection of outboard lower edge chambers
5. Parenthetical entries are based on 90% maximum practical cube utilization

Source: Cargo Logistics Airlift Systems Study (CLASS), Cross Impact between the 1990 Market and the Air Physical Distribution System, Volume 3, Douglas Aircraft Company, Long Beach, June 1978.

EXHIBIT 9

reached with the 6 meter and 12 meter container. Further, both figures indicate that the other containers that are widely used are close to this theoretical maximum. This would indicate that the physical dimensions of containers will stay relatively the same. This assumption is enhanced by the fact that all outyear projections presently available indicate the 3 meter, 6 meter and 12 meter containers as being the prime types of containers for intermodal shipments.

It is further anticipated that the LD units shown, which are the most commonly used, will continue to be used with the possible exception of the DC-8 belly container. This observation is reasonable since the vast majority of belly containers were designed and are an integral part of the wide-body jet aircraft.

In the mainstream, the intermodal container demand will be constrained by the types of aircraft in service and the volume of cargo carried. In today's air cargo market, some unknown limit exists on the number of M-1 or M-2 containers needed due to the types of air cargo handled. As long as air cargo consists primarily of perishable high value and emergency cargo, the intermodal air cargo concept is not justified [1:117]. However, if the major air cargo carriers continue to develop intermodality, market the concept and achieve volume shipments of cargo, the container, specifically the cube efficient M-2, should become an important part of an integrated logistics system.

B. AIRCRAFT COMPATIBILITY

In today's environment of converting passenger aircraft to cargo use, the container for air cargo is somewhat of a by-product. Even though all of the wide-body jets can accommodate the M-1 or M-2 intermodal container and several civilian derivatives of military cargo aircraft can also accommodate containers, the B747F is the only commercial aircraft that can handle large numbers of intermodal containers, and the only one that can accommodate two lanes of containers.

Although present wide-body aircraft are compatible with containers, and vice versa, the present situation does not fully exhaust container possibilities. This is due to the fact that commercial aircraft are designed to carry people, not cargo. This has led to several studies concerning aircraft designed for the cargo function. These studies have resulted in projected aircraft in the 1990 time frame to be three and four lane "container-in-fuselage" type aircraft, as well as three and four lane "container-in-wing" spanloader type aircraft. In these cases, the aircraft have been designed assuming the M-1 or M-2 container as the primary shipping medium. These types of assumptions seem valid since other transportation mediums revolve around the 6 meter container, so it would appear reasonable they will not alter their massive investment.

Based on the foregoing, it is reasonable to predict that intermodal containers will become more prevalent, will continue to be compatible with present wide-body aircraft, and will be compatible with projected future generations of cargo

dedicated aircraft. There are certain problems, however, about the future of these projected aircraft that will be addressed below.

It is also apparent that as larger numbers of wide-body aircraft enter the commercial cargo fleets, the problem of non-compatibility will be reduced, and, hence, compatibility will increase. By introduction of wide-body jets, not only is main cargo hold compatibility increased, but lower deck compatibility is increased also, due to commonality amongst the LD units used in wide-body aircraft.

C. ECONOMICS

One must remember that above all, no matter how grandiose the scheme, if money cannot be made, the scheme will probably not come to fruition. Airlines are now flying passengers at lower fares, with higher densities, resulting in larger profits. The same can be inferred in the air cargo field. The relevance of the analogy, of course, is due to economics of scale, and until there are sufficient numbers of lower-priced containers to yield lower shipping costs to the consumer, the air cargo industry will continue to hold less than one percent of the domestic cargo market, and probably will continue to lose money in the air cargo business [7:55]

Complicated formulas and sophisticated analytical techniques are missing from the above discussion because they are simply not available, since the airline industry, when analyzing air cargo, does not have a solid data base. Until a good data base can be generated, sufficiently

sophisticated models will not be available to make accurate predictions on the strategies required to achieve more rapid growth [6:32].

This point was driven home quite explicitly by E. H. Boullioun, President of Boeing, at the Ninth International Forum for Air Cargo held at Vancouver in September of 1978.

> In my view, the airframe manufacturers should not at this time gamble on speculative programs for air cargo. Airline top and middle managers--especially at the combination carriers--have not done enough homework on cargo. Their major problem is not equipment but marketing [13:66].

Mr. Boullioun continued by saying that airlines must get a more accurate fix on freight costs and profitability, on how much of the currently available space is being efficiently marketed, on what products constitute air eligible freight and on techniques necessary to capture some of the present freight that is being moved by surface modes.

Air containers may follow the same history as surface containers, unless someone takes a hard look at what steps need to be accomplished to obtain healthy growth with sufficient profit.

What is meant here is the following: Surface containers presently are profitable; however, during their growth stage, the surface container industry experienced some of the same growing pains the air container is experiencing today. The air cargo industry is not making use of the surface container industry's experience to the fullest. Certainly, growth of the air container can occur only with

an aircraft that is designed to carry cargo, not an aircraft designed to carry people that has been converted to carry cargo. However, referring again to Mr. Boullioun of Boeing,

> When our industry starts to really understand the cargo market and its economics, then, and only then, I can see Boeing prepared to furnish a new technology freight airplane [13:66].

Douglas Aircraft supported this statement, as did Lockheed, and all three were in agreement that new technology freighters are not in sight until the mid 1990's or later. This attitude by aircraft manufacturers could be a stumbling block to rapid growth in container usage, but there are viable alternatives.

There is the possibility of converting Douglas DC-8's and Boeing 707's to cargo use. However, the demand for aircraft to carry passengers, a surely profitable venture, is choking off the supply of available aircraft for conversion. Further, these aircraft are not compatible with air-type intermodal containers.

Another possibility, as proposed by Lockheed, is the conversion of military freighters such as the C-130, C-141 and C-5A to handle intermodal containers.

> Lockheed has a candidate for this role in the L-100-50 derivative of the Hercules civil/military transport, and Ormsby (Lockheed's President) said that airlines have shown considerable interest in the proposal... Depending on the configuration, the Dash 50 could carry payloads of up to 72,000 pounds and could accomodate up to ten ten foot (6 meter) containers [13:67].

These proposals, of course, are holding actions until the new technology aircraft come on the scene to provide more efficient movement of containers. However, it is

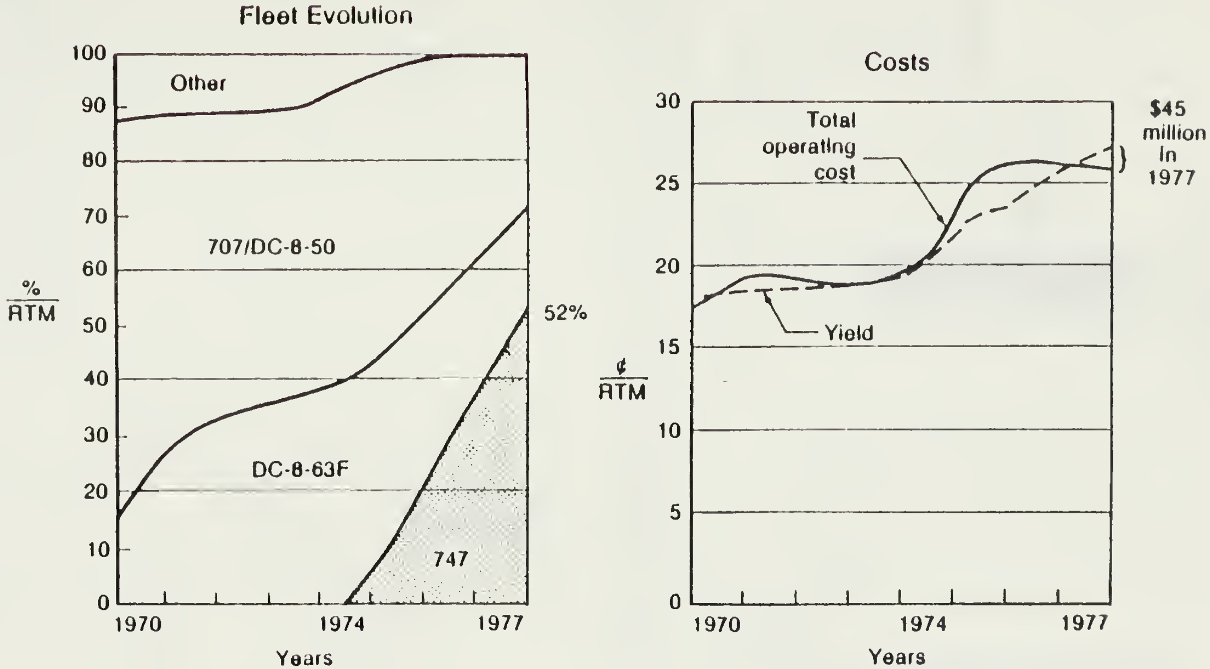
maintained by several airlines that this holding action will greatly facilitate more rapid growth of the air container market, and therefore air cargo.

These general remarks can be further amplified through the presentation of several cogent points and the following illustrations. In Exhibit 10, on the following page, the cost chart shows the dramatic increase in costs plotted against cents/revenue ton mile during the 1974-75 time frame. The reader should realize that this cost increase was mostly due to the Oil Embargo and the resultant increase in fuel prices. In 1979 the world is again experiencing dramatic increases in oil prices, which will increase the cost of jet fuel. Jet fuel is one of the prime ingredients needed on a continuing basis for large scale air cargo movement, and, if this cargo movement is hindered, the resulting small shipments would essentially stalemate growth of air containers.

Exhibits 11A and 11B on the following page highlight further possible problems that are economically equivalent to a type of 'domino theory'. If the Russellville concept is correct, Exhibit 11A reveals that advanced-designed air freighters are indeed cost effective and competitive with trucks, and may even be competitive with rail shipments. This is predicated, however, on a growing economy that demands more and more long haul, high value, rapid movement of cargo. During a period of slow growth, or stagnation, these markets would dwindle, creating little or no need for

Current Trends

U.S. Carriers All Cargo Operations

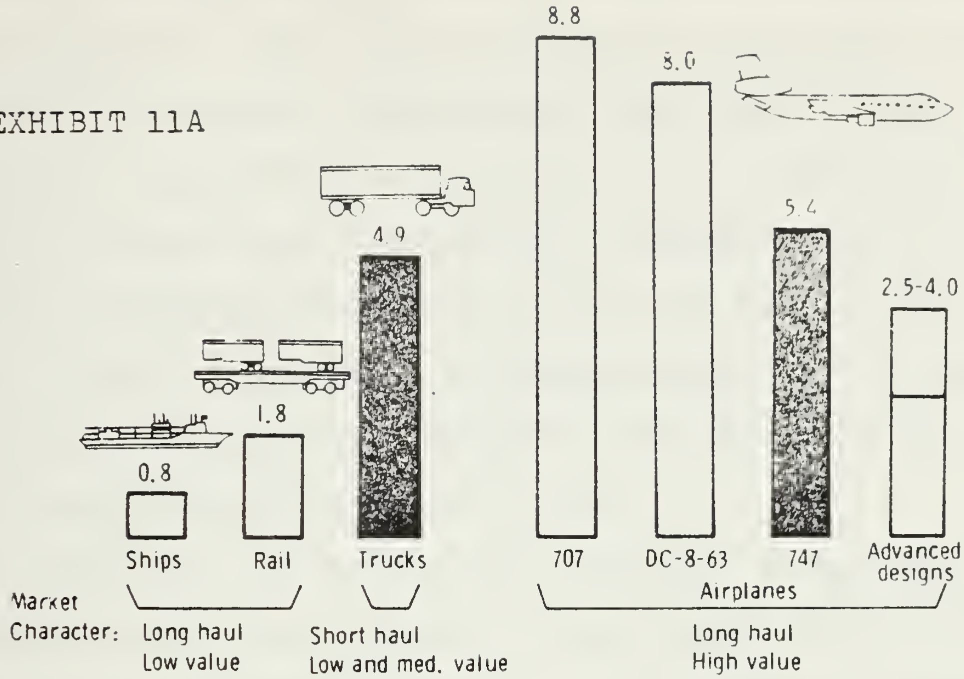


Source CAB form 242

Source: Intermodal Air Freight System Progress Report, Boeing Commercial Airplane Company, Air Freight Systems Office, Seattle, March 1979.

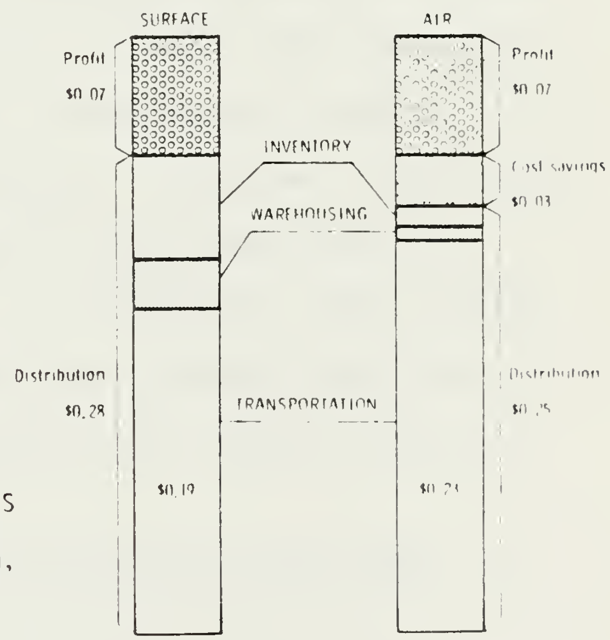
EXHIBIT 10

EXHIBIT 11A



TRANSPORTATION COST IN CENT PER TON-MILE (Source: The Russellville Concept, An Intermodal Cargo Transportation System, Russellville, Arkansas, February 1978, p. 47).

EXHIBIT 11B



THE CONCEPT OF TOTAL DISTRIBUTION COSTS (Source: The Russellville Concept; An Intermodal Cargo Transportation System, Russellville, Arkansas, February 1978, p. 43).

Source: Air Cargo: An Integrated Systems View, 1978 Summer Faculty Fellowship Program in Engineering Systems Design, NASA-Langley Research Center, Hampton, September 1978.

additional containers, and, hence, no need for an advanced-design freighter. This emphasizes the fact that the economic principles of container usage demand large cargo volume.

Further, the problem is compounded when looking at total distribution cost concepts in a stagnant market. Inventory and warehousing costs as shown in Exhibit 11B on page 83 would increase in a stagnant market due to lack of sales, and would prevent shippers from incurring the cost premium paid for rapid shipment by air.

The foregoing illustrates that container development is predicated on air cargo growth, and air cargo growth depends on a healthy and growing economy. If one assumes growth will continue as it has, the conclusion reached must be to go forward with air container construction and use. This leads to advanced-designed cargo aircraft, which will spur even further development of air containers. However, if one assumes poor growth, or a recession, container demand would be minimal due to small demand for air cargo service.

Several points mentioned in the Douglas' CLASS report deserve mention here, for they are extremely important in analyzing future air cargo growth, and, hence, container demand.

1) Pallet tare weight is considerably less than containers.

2) Theft, damaged and missing cargo are less with containers.

3) The container is capable of generating more revenue than pallets, given the container is fully utilized.

4) In the short-haul environment, the container is considerably better.

5) In the long-haul environment, the pallet is marginally cheaper.

6) Container acquisition costs and maintenance costs are considerably more than pallets.

7) Handling equipment costs are about the same.

8) Pallet technology has been advanced to its limit, while container technology is still improving. [5:340]

The foregoing information tends to indicate that:

1) For massive growth and usage of containers, better definition of markets will have to be obtained.

2) Containers are marginally better than pallets, assuming a growing economy, in a wide range of uses.

3) Containers are considerably better than pallets, assuming a growing economy, in a restricted range of uses.

4) Container trade-offs must be made against efficiency, loss, pilferage, damage, insurance costs, and greater tare weight.

5) Air containers should not be considered as individual entities, but should be conceptualized as part of an integrated logistics network.

6) Container growth and use will only occur as rapidly as the industry and the economy will allow growth and use to develop.

VIII. PROJECTED MILITARY CONTAINER USAGE

To attempt to predict what use military containers will have, the types of containers that will be available and the compatibility that will exist is indeed difficult. However, due to the long lead times involved in military procurement, the future short-term hardware owned by the military establishment can be more easily predicted than in the civilian community.

A. PHYSICAL CHARACTERISTICS

In the near term, it is clear what types of containers will be available in the military inventory. There is no scheduled procurement of general purpose MILVANS or any other type of general purpose container through FY 1985. Also, as previously mentioned, the only scheduled procurement of containers consists of the ammunition MILVAN and refrigerated MILVANS. Schedules call for the procurement of adapter pallet for MILVANS and new handling equipment, primarily for use with intermodal containers carried on CRAF aircraft. These procurements have all been mentioned previously. At the present time, only the container inserts are awaiting a procurement decision.

What this indicates is a military container inventory of steel 2.44m x 2.44m x 6m units, in fairly small quantities, and adapter pallets to allow for air shipment

of these units. These containers will be moved primarily by surface modes, with air shipment resorted to during emergencies. If the container inserts are approved for procurement, they will provide a capability to achieve smaller unit loads, while promoting a "box in a box" concept that will further add to tare weights.

There are presently no indications that the military is considering the purchase or lease of air intermodal containers. This further supports the conclusion that the 463L Material Handling System will remain in effect for some time to come, unless a radical and rapid change in packaging philosophy is generated within DOD. Therefore, current projections indicate that unitization will rely on MILVANS, possible container inserts, and the 463L pallet. The primary air cargo shipment medium will be the pallet, while the MILVAN will remain essentially an Army piece of equipment. The ALOC system will expand, which in turn will result in a higher degree of unitization within the military.

B. AIRCRAFT COMPATIBILITY

If one wishes to view MAC in isolation, it may be said that on the grounds of compatibility the Air Force has produced an efficient instrument of air cargo movement. When one expands the environment to include the civilian community, a different conclusion may be reached.

The 463L pallet, as previously mentioned, is fully compatible with all major MAC aircraft. This compatibility is expected to continue at least through the early 1990's,

since no major aircraft procurement is scheduled until that time. The only procurement that is desired is the so-called C-XX large cargo transport. The military sees a need for this advanced all-cargo aircraft in the 1990 time frame, with a desired military procurement of 60 units out of a total 300 units. The balance, of course, would be purchased by civilian airlines for joint use under CRAF auspices. These figures assume many variables, the most important of which are projected airlift needs around the world, which are tenable at best. The base projection is that the capability to airlift 370,000 tons to Europe in 30 days is needed, and the Government Accounting Office (GAO) has strongly critisized these figures [1:260].

The C-XX proposal is not even in the design stage; therefore, one could postulate many theories as to its eventual compatibility with the existing 463L system, or containers. Since the program is proposed to be a joint civilian-military purchase, and the civilian community would be acquiring the majority of the aircraft, it would want these aircraft to be container compatible. It seems apparent that the military, given its dependence on CRAF during emergencies, will have to work together with the CRAF airlines in the design and acquisition of any projected air freighter.

Further, it is reasonable to assume that any joint air-freighter venture would be dominated by the civilian community in the area of cargo conveyances (pallets or containers), and that the civilian airlines would refuse to

make massive investments in a freighter configured only to be compatible with the 463L system. It is further hypothesized that the military must look closely at container systems for future aircraft acquisitions, and retrofit present aircraft over several years, so the military is compatible with the civilian community.

C. ECONOMICS

It is argued that the cost to replace the 463L system is prohibitive, and therefore replacement should not be considered [25:23]. This philosophy is not necessarily incorrect, it is merely not supported by substantive data. A long-range analysis has not been conducted to determine if the massive container investment needed for DOD (not each service independently, as has been done, but for DOD as a whole) to replace the 463L system would be cost-effective. Granted, the analysis of such a program would be massive. However, the military is saying no to such a replacement program on educated guesses, which may be valid, and then, again, may be in error.

It is postulated that: considering the massive benefits and increased profits accruing to the maritime container industry, the obvious commitment by civilian air cargo carriers to increasing containerization, and the fact that these ventures would not have been undertaken without sound economic judgement, the military must further analyze its minimum commitment to containers. This is only reasonable

since the military may be able to realize the same benefits that the maritime industry has enjoyed.

IX. ANALYSIS OF PROJECTED CONTAINER USAGE

An attempt will be made in this chapter to compare container usage in the military with that in the civilian community. The comparison will be made concerning the projection of expected container or unitization acquisitions, and their interface with aircraft.

A. PROJECTED SIMILAR CONTAINER USAGE

In the future, military and civilian container systems are anticipated to be similar in the following respects:

1) The MILVAN will continue to be almost identical with its 6 meter counterpart in the civilian surface mode.

2) The refrigerated MILVAN will be almost identical with its 6 meter counterpart in the civilian surface mode.

3) Container handling equipment will be compatible with air or surface containers, and will be of standard commercial design.

4) As more DC-10 aircraft are used, a greater number of LD units will be used for baggage.

5) ALOC, though not a container program, is a unitization program for consignor to consignee transfer, and is similar to the palletization in commercial use. ALOC shipments are expected to increase.

These major points of commonality are expected to exist through the next decade. These may well be the only points

of commonality well into the 1990's, depending on yet unscheduled procurements.

B. PROJECTED DISSIMILAR CONTAINER USAGE

Military and civilian container systems are anticipated to be different in the following respects:

1) The ammunition MILVAN will continue to be structurally different due to its unique requirements.

2) If container inserts are added to the military inventory, there will be no parallel addition in the civilian community.

3) With the 463L system projected to remain in effect, the material packaging systems (military vs. commercial) will grow farther apart.

4) The 463L system will also widen the military-civilian gap in organic material handling capability, as the commercial air cargo network tends towards intermodalism.

5) The civilian air cargo community is using air intermodal containers, and increasing their use, while the military has no plans to acquire or lease these units.

6) The percentage of civilian air cargo that is containerized is expected to increase; the military expects modest increases in ALOC shipments, with little or no increase in container shipments.

7) Military stuffing procedures will tend to get better, but will not approach the civilian sophistication.

8) The intermodal gap will widen, as no concerted effort is in effect to coordinate the military and civilian effort.

C. ANALYSIS

There are several facts concerning military/civilian commonality in air cargo that are self-evident. Some are a little more difficult to make apparent, but have been mentioned previously in this report.

The civilian air freight community is deeply involved in procurement of wide-body aircraft and container handling equipment. Initial container growth was rapid, slacked off temporarily, and then picked up again after the carriers had mapped out their strategies. The air cargo carriers had to containerize, as did the maritime and surface cargo industry, so that they could offset the rapidly increasing costs of labor with capital-intensive investments that could be depreciated. The air cargo industry is at last doing in-depth economic analyses for future air cargo markets, and is working with other modes to change obstacles in the way of intermodality. It must be kept in mind that all of the changes occuring now, and those to come, are being implemented to achieve high efficiency, reduce costs, and hopefully increase profits.

Unlike the civilian community, the military is relying on a proven, yet obsolescent pallet system. The entrenched 463L pallet system is seen as the military air cargo handling system through the 1980's and into the 1990's. This system could be considered satisfactory, if civilian container usage projections were not so large. Further, the widening gap between container and pallet usage would be of no consequence if the military did not depend on the civilian

air cargo system for strategic airlift. In the military world of ten to fifteen year procurement lead times for major equipment, it is necessary for the services to act jointly with the civilian cargo community to produce a common system. The course now being followed is leading the military toward further air cargo handling isolation from the rest of the air cargo community.

The magnitude of this separation can be more fully illustrated through projections of cargo airlift in the out-years. Figures presented to the DOD Joint Container Steering Group in January of 1976 indicate a 2400 twenty foot equivalent unit (TEU) demand per day at New York's JFK airport in 1985. This does not include projected belly freight, and is a modest estimate based on past experience. If this is projected to the year 2000 at a five percent compound growth rate, the demand will increase to 5000 TEU's per day at JFK. This reflects only one major airport in the United States. Airports such as Chicago, Los Angeles, San Francisco, Boston, Dallas-Ft. Worth and Atlanta would have smaller demands, but large nonetheless [12:2]. This kind of large volume demand, if realized, will place an inordinate demand on break-bulk methods, but could be reasonably managed through the use of containers.

Contrasting this kind of massive daily volume with military projections is staggering. Based on May and June 1978 military air cargo flow to Europe and the Mediterranean, a potential of 1592 TEU's per month exists. If one assumes

the same 5 percent compound growth, which may not be valid due to the military's increasing use of commercial air cargo service, the 1985 Europe/Mediterranean demand will be 2240 TEU's per month, or 74.67 TEU's per day. At the same projected increase, the year 2000 demand would be 4657 TEU's per month, or 155 TEU's per day [9:26]. This kind of projected demand is extremely small in comparison to the civilian counterpart, and is unlikely to influence the civilian community in their plans for advanced air cargo handling systems. This exorbitant gap between sizes of systems will most definitely have a profound effect on the military, if CRAF is called upon for logistics support.

The information presented above indicates that a commonality gap exists between military and civilian air cargo handling systems, and that this separation will most likely widen in the future. This trend may be viewed as positive or negative depending on one's perspective.

The present facts and projected trends substantiate the growing rift between the two logistics systems, and indicate that the military will be hard pressed to ship the massive amounts of cargo needed in a rapidly escalating situation due to break-bulk methods, insufficient manpower, and most importantly, lack of compatibility with a 50 percent partner in international cargo shipment.

X. CONCLUSIONS

A. THE INTERMODAL OUTLOOK

With the growing need for more transportation services as our economy, as well as the international economy grows, it is reasonable to conclude that civilian air cargo shipments, and specifically intermodal shipments, will expand at an increasing rate. It is also reasonable to conclude that as the civilian air cargo industry obtains a firm data base for conducting cost analyses, the ability will become available to reduce and streamline indirect operating costs.

Furthermore, it is evident that the civilian air cargo industry is at the threshold of instituting a full blown intermodal air container program, one that has the potential of becoming a part of a fully integrated intermodal container network. It is only the cooperation and communication among all modes (which may not be simple) that can bring a complete intermodal network to fruition.

Along with the new technology must go the necessary logistics to ensure that, after transport, the shipment reaches its final destination on schedule. It does little good to have a fast and reliable means of transportation, if the shipment sits at the terminal for extended periods after arrival. This implies that a ground support network of comparable sophistication is also needed.

It has already been mentioned that the military has a large investment in the 463L pallet system. This system grew out of different transportation requirements, before intermodality was introduced as a logistics concept. For the Department of Defense to attempt to scrap this system would necessarily meet extreme resistance at the congressional level. The resistance, of course, would be in direct proportion to the estimated costs of replacing the present bulk shipment and pallet shipment modes. These costs would be extremely high.

However, it must be appreciated that the present 463L material handling system is getting older, and needs replacement; a topic that has been addressed. It appears necessary that a cost analysis be done to determine if new intermodal containers can be gradually phased into the military logistics network. This could be done with the MILVAN program remaining in effect, and the MILVANS could continue to be used for surface shipment as well as emergency air shipment. There is a need for this system, as it would afford the logistics manager the ability to effect rapid delivery of goods. This would provide the needed interface with the commercial cargo carriers if their services were required.

B. SUMMARY OF MAJOR POINTS

What follows is a list of major points concerning each type of cargo system in a comparative manner. This listing should not be construed as all inclusive, rather, as

representative of the major advantages and disadvantages of commercial air cargo handling in relation to military air cargo handling.

463L PALLET

1) Efficient load-unload cycle within DOD.

2) Inefficient load-unload cycle if used outside DOD.

3) Requires break-bulk of containers at terminal necessitating longer hold times.

4) Requires sort and palletization of shipment.

5) Does not provide true direct supplier to customer service.

6) Both military and civilian cargo handling equipment can handle these pallets.

7) Has a good packing density, but is not cube effective in aircraft.

8) System does not accept containers easily.

9) Material subject to pilferage and breakage.

MILVAN

1) Inefficient load-unload cycle in DOD or in civil market.

2) Exhibits extreme weight penalty.

3) Is not subject to significant pilferage or breakage of material.

4) Has an efficient packing density.

5) Has a good cube utilization.

6) Is fully intermodal for all modes except the air mode.

7) Provides for direct supplier to customer service.

8) Requires an adapter to be transported by air mode.

9) Can be stacked six high.

INTERMODAL CONTAINER

1) Efficient load-unload cycle in civilian market.

2) Inefficient load-unload cycle in DOD with present equipment.

3) Is not subject to significant pilferage or breakage of material.

4) Is very weight efficient.

5) Has a high price tag.

6) Has an efficient packing density.

7) Has a good cube utilization.

8) Is fully intermodal.

9) Provides for direct supplier to customer service.

10) Is more corrosion resistant than the MILVAN.

11) Presently the state of the art.

12) Has a much faster delivery time than other methods.

13) Can only be stacked two high.

C. CONCLUSION

Based on some of the observations made, there appears to be a need to provide a faster and more reliable means of material movement between consignor and consignee. This can be affected through the use of intermodal containers; however, the cost of rapid change to intermodal containers from the present DOD 463L pallet system for air cargo is prohibitive.

Nevertheless, the need does exist, and as cargo shipments become larger, and the anticipated response time is decreased to be effective in responding to conflicts, some commonality must be established. As early as 1976, a joint Department of Defense (DOD)-Department of Transportation (DOT) study in concert with commercial industries came to some rather interesting conclusions:

1) There is a need at present for an integrated surface-air transportation system that can accommodate mass movements of freight by air.

2) The catalyst to bring this about is a family of unit load devices (trailers or containers) that are <u>not captive</u> to any one mode.

3) The concept of an integrated surface-to-air system is operationally practical.

4) A common set of commercial and military requirements for such a system can be generated which can be satisfied efficiently [17:1].

These points are not great relevations, rather; they are the placing on paper of what exists and what must be done. The above comments were further supported by the Project Intact report completed in the middle of 1976. Project Intact (Intermodal Air Cargo Test) was a joint venture by the military and various civilian firms. The test confirmed that intermodalism, in concept and in use by the military and civilians, was feasible and effective in providing rapid

movement of cargo by air, and that the two groups can, if willing, work together towards a common logistics goal. This further highlights the fact that it is imperative that the government and commercial air cargo carriers coordinate and establish a common set of guidelines, while they strive to achieve commonality in equipment. This can be accomplished most easily through testing and evaluating systems, and through gaining the realization that containerization is the most economical program in the long run.

As previously mentioned, the sea-land-rail shippers have realized a reduction in operating costs due to containerization, and the air industry is beginning to realize that these benefits outweigh costs only in the long run, for each carrier experiences high initial start up costs to implement these new systems.

Overall, there exists a need to reduce handling time, obtain a better cube utilization, and have the ability for shipment transfer between shipping point and destination without further break-bulk handling. Succinctly, there are several conclusions that are readily apparent:

1) Larger airplanes do not necessarily make air logistics more efficient. A more sophisticated packaging and handling system is necessary for more efficient cargo handling.

2) An effective interface must exist between the air mode and all other modes. This interface is virtually non-existent in the military.

3) The military does not promote unitization; rather, it fosters single package shipments.

4) Labor intensive handling costs have overtaken depreciated capital intensive handling costs.

5) Peacetime military air cargo shipment requirements will not significantly affect civilian air cargo handling strategies.

6) The military must coordinate its packaging and handling strategy with the civilian community.

7) A cost-benefit analysis of intermodal containers would force the military to analyze total distribution concepts, rather than isolated areas.

8) The 463L system will remain in effect for some time.

For the time being, the Department of Defense will continue to use the present break-bulk shipment methods. Extensive use of the present system of pallets and MILVANS, with planned upgrading of the present system, will surely place the military at a disadvantage in future years, if assistance is solicited from the commercial sector through CRAF.

The military logistics system is operating without state of the art technology, and until new compatible systems are slowly phased in to the military logistics framework, DOD will be at a disadvantage in transporting massive amounts of cargo by air during times of crisis, in a timely fashion. Moreover, our ability to mobilize the commercial cargo market for military use will be extremely hampered. Improved

coordination must be achieved to secure systems that will enable the United States to meet its logistics challenge in the future.

XI. RECOMMENDATIONS

Due to the broad nature of the subject matter, and time constraints placed on the research towards this thesis, all of the subjects were not covered in detail. Further, the possible data available to the author were most likely not included due to these constraints. The author, therefore, recommends that further study be conducted in the field of air containerization, and that the specific items listed below should be given the utmost attention.

1) An in-depth cost analysis must be accomplished, integrating civilian-military needs, to provide sound financial information.

2) An analysis of future container needs, and support needs, must be conducted in harmony with the civilian community.

3) Attempts should be made to compare effectiveness of intermodality in relation to pallet-MILVAN air shipments.

4) Throughput analysis must be done on a comparative basis, with consideration given to bulk of shipment, type, unit load configuration, priority, storage locations and administrative lead time.

5) Efforts should be made to provide standardization through the use of containers in the military-civilian air cargo arena.

In the final analysis, todays sophistication demands cooperation, thought reaction and interplay of ideas. To do less is to achieve less. Only through a cooperative effort by all members of DOD and the civilian air cargo community can we hope to have the necessary logistics arm to support a rapidly developing scenario. The air container is the medium by which a compatible and responsive air cargo system can be realized by the United States air cargo network.

APPENDIX A

A-1

20'x8'x8'6" Steel Van Container with 73 Ton Rated Corner Post Structure Ventilated

Specifications

Cubic Capacity	33.1 cu. m (1,169 cu. ft.)	
Gross Rating	20,320 kg (44,800 lbs.)	
Tare Weight	2,380 kg (5,250 lbs.)	
Corner Post Structure Rating	73,000 kg. (160,950 lbs.)	
	External *(Nominal)*	**Internal**
Length	6,000 mm (20 ft.)	5,893 mm (19 ft. 4 in.)
Width	2,438 mm (8 ft.)	2,337 mm (7 ft. 8 in.)
Height	2,591 mm (8 ft. 6 in.)	2,388 mm (7 ft. 10 in.)
	Height	**Width**
Door Aperture	2,286 mm (7 ft. 6 in.)	2,337 mm (7 ft. 8 in.)

CERTIFICATIONS

I. Approved for Transport under Customs Seal.
II. U I C Registered.
III. Wood components treated to satisfy Australian Quarantine Authority requirements
IV. Certified by Bureau Veritas

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.

20' x 8' X 8'6" Steel Van Container
with [illegible] Ton Rated Corner Post Structure
Ventilated

Source: CTI Equipment Catalog
Container Transport International, Inc.
White Plains, N.Y.

40'x8'x8'6" Steel Van Container with 84 Ton Rated Corner Post Structure
Ventilated with Tunnel Recess

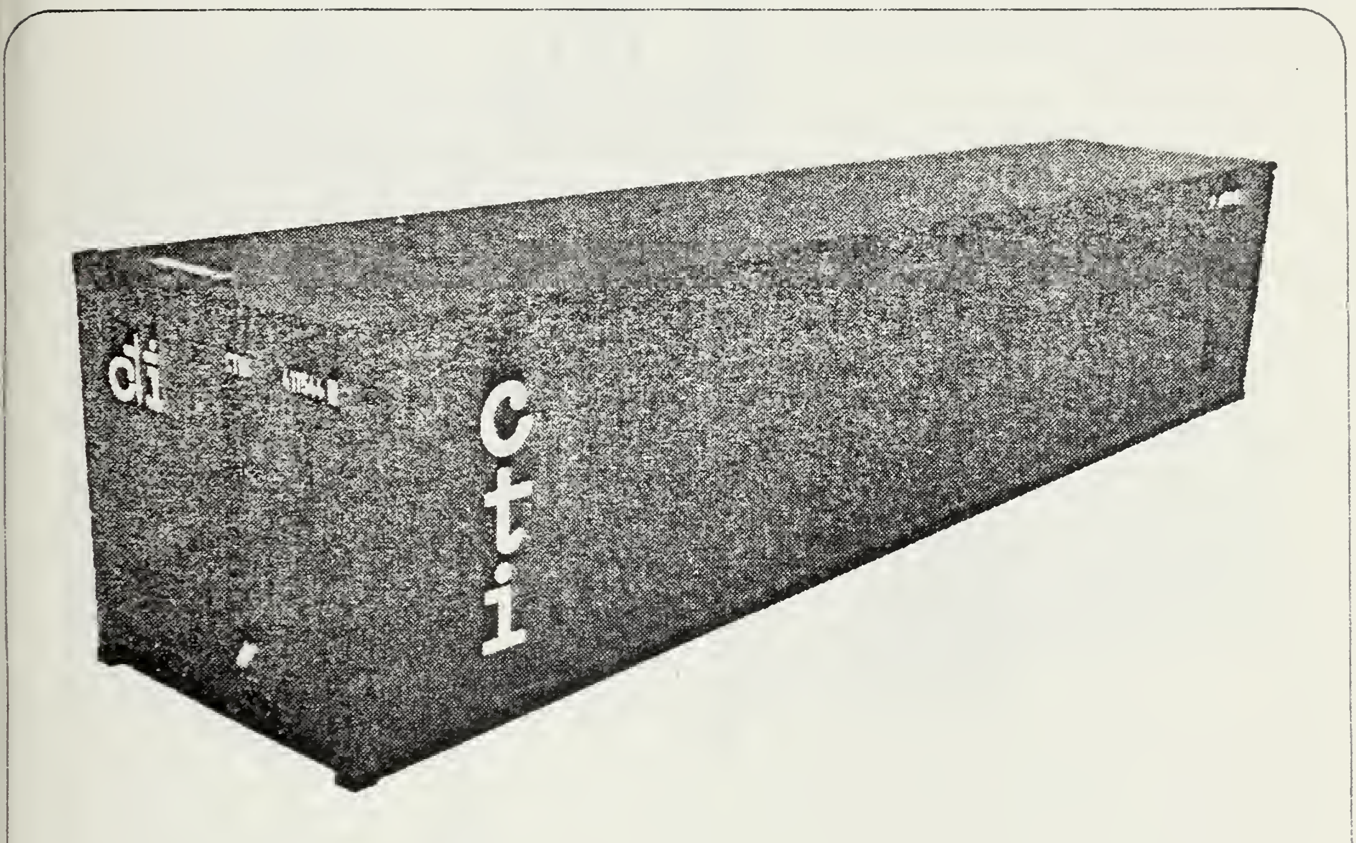
Specifications

Cubic Capacity	67.6 cu. m (2,387 cu. ft.)	
Gross Rating	30,480 kg (67,200 lbs)	
Tare Weight	4,260 kg (9,390 lbs.)	
Corner Post Structure Rating	84,000 kg (185,185 lbs.)	
	External *(Nominal)*	**Internal**
Length	12,000 mm (40 ft.)	12,040 mm (39 ft. 6 in.)
Width	2,438 mm (8 ft.)	2,337 mm (7 ft. 8 in.)
Height	2,591 mm (8 ft. 6 in.)	2,388 mm (7 ft. 10 in.)
	Height	**Width**
Door Aperture	2,286 mm (7 ft. 6 in.)	2,337 mm (7 ft. 8 in.)

CERTIFICATIONS

I. Approved for Transport under Customs Seal
II. U.I.C. Registered
III. Wood components treated to satisfy Australian Quarantine Authority requirements
IV Certified by Bureau Veritas

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.



[illegible] x 8' x 8'6" Steel Van Container
with 34 Ton Rated Corner Post Structure
ventilated with Tunnel Recess

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.

20'x8'x8' Steel Open Top Container

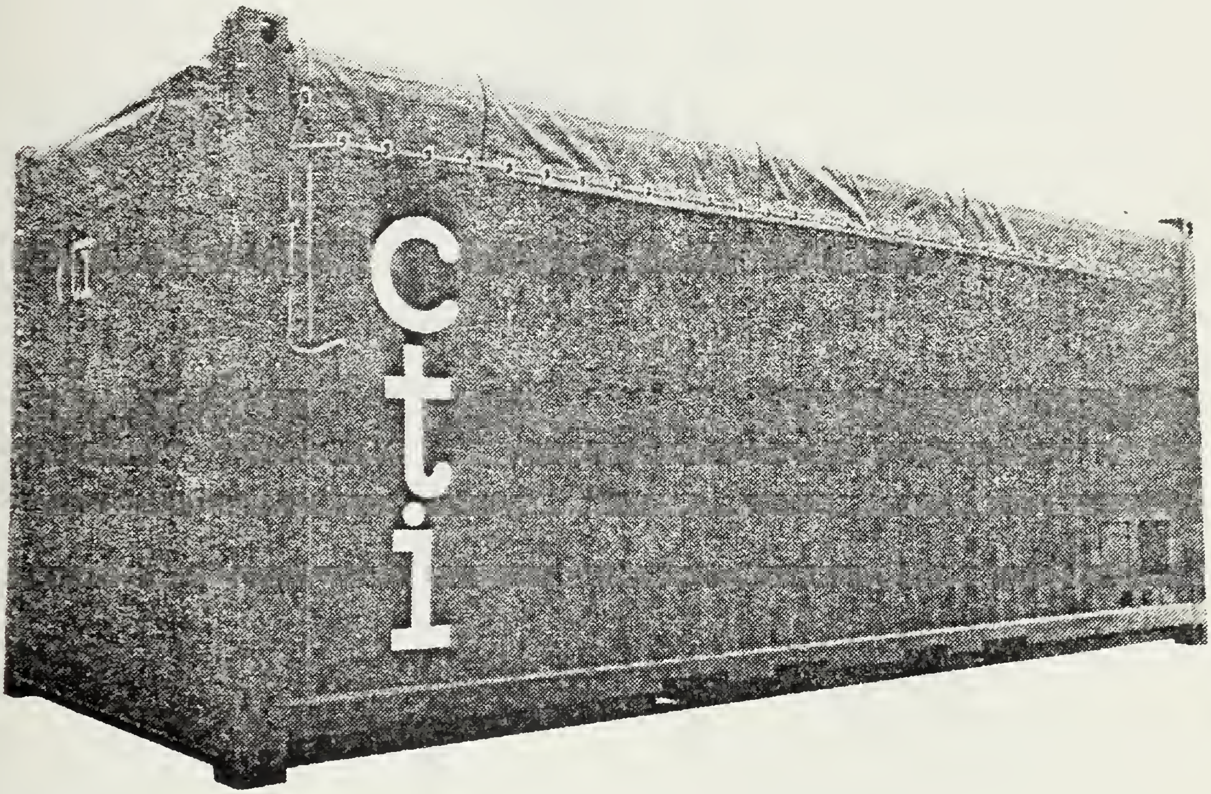
Specifications

Cubic Capacity	29.4 cu. m (1,037 cu. ft.)	
Gross Rating	20,320 kg (44,800 lbs.)	
Tare Weight	2,190 kg (4,829 lbs.)	
Corner Post Structure Rating	45,700 kg (100,800 lbs.)	
	External *(Nominal)*	**Internal**
Length	6,000 mm (20 ft.)	5,893 mm (19 ft. 4 in.)
Width	2,438 mm (8 ft.)	2,311 mm (7 ft. 7 in.)
Height	2,438 mm (8 ft.)	2,134 mm (7 ft. 0 in.)
	Height	**Width**
Door Aperture	2,032 mm (6 ft. 8 in.)	2,286 mm (7 ft. 6 in.)

CERTIFICATIONS

I. Approved for Transport under Customs Seal.
II. U.I.C. Registered.
III. Wood components treated to satisfy Australian Quarantine Authority requirements.
IV. Certified by Bureau Veritas.

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.



20' X 8' x 8' Steel Open Top Container

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.

40'x8'x6" Steel Open Top Container
With Tunnel Recess

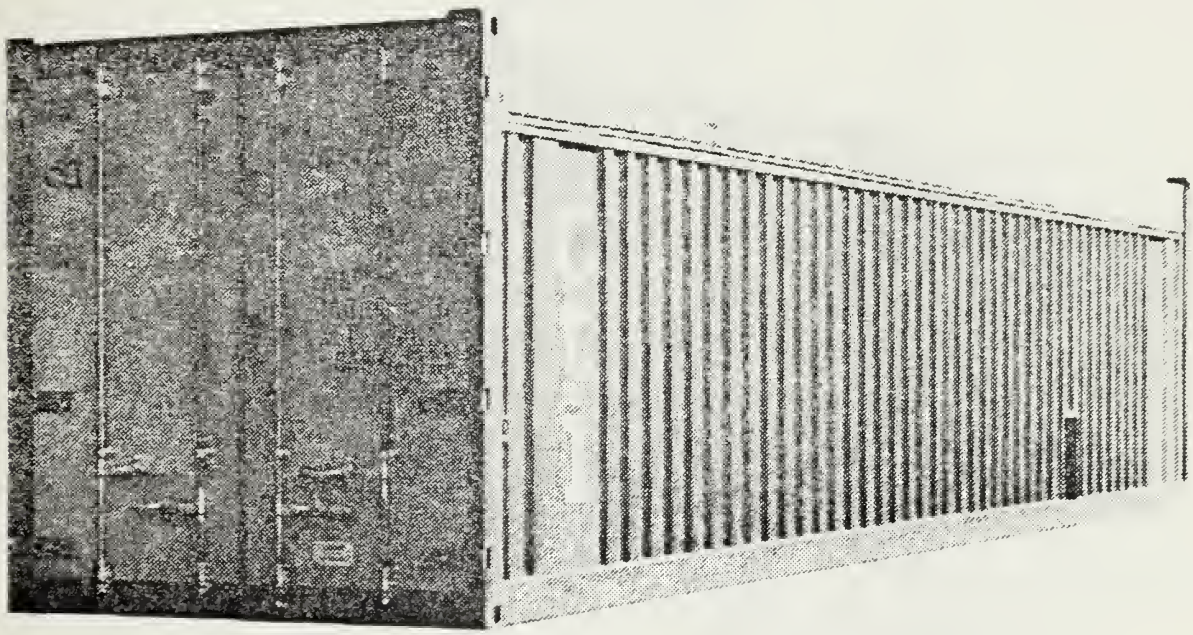
Specifications

Cubic Capacity	64 cu. m (2,260 cu. ft.)	
Gross Rating	30,480 kg (67,200 lbs.)	
Tare Weight	4,750 kg (10,475 lbs.)	
Corner Post Structure Rating	69,000 kg (152,000 lbs.)	
	External *(Nominal)*	**Internal**
Length	12,000 mm (40 ft.)	12,065 mm (39 ft. 7 in.)
Width	2,438 mm (8 ft.)	2,337 mm (7 ft. 8 in.)
Height	2,591 mm (8 ft. 6 in.)	2,337 mm (7 ft. 8 in.)
	Height	**Width**
Door Aperture	2,286 mm (7 ft. 6 in.)	2,337 mm (7 ft. 8 in.)

CERTIFICATIONS

I. Approved for Transport under Customs Seal.
II. U.I.C. Registered.
III. Wood components treated to satisfy Australian Quarantine Authority requirements
IV. Certified by Bureau Veritas

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.



40' x 8' x 8'6" Steel Open Top Container
with Tunnel Recess

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.

20'x8'x8' Aluminum Air/Land Container

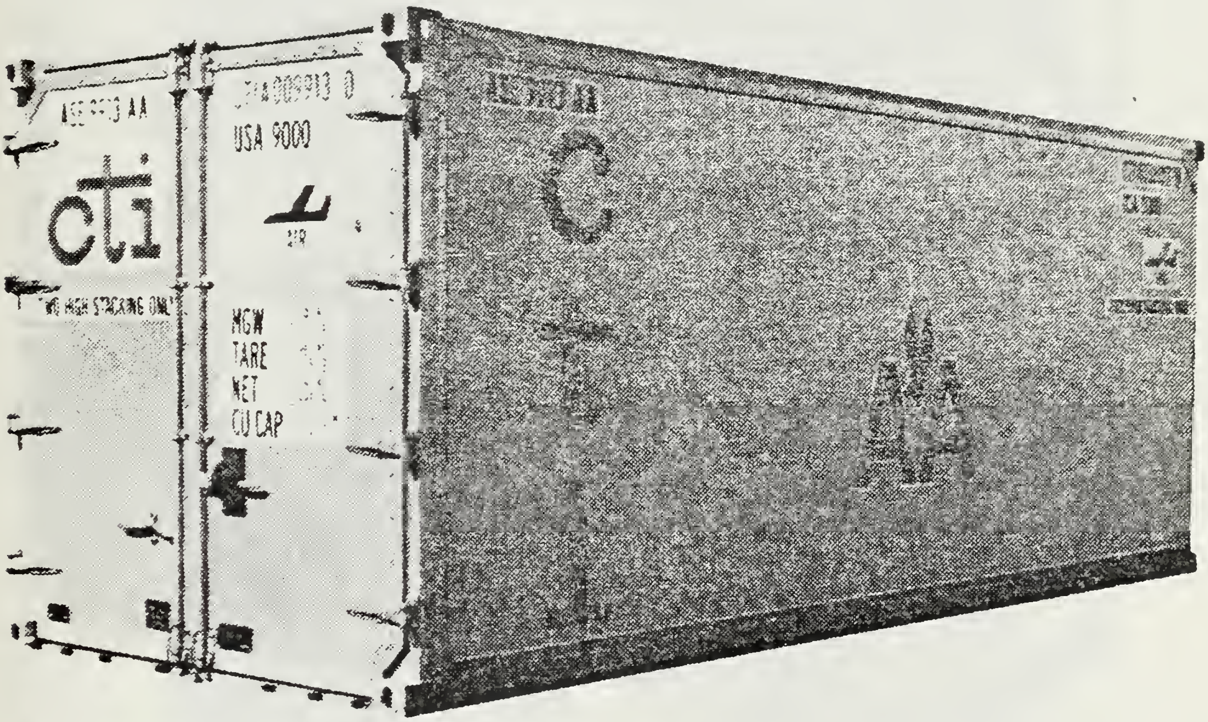
Specifications

Cubic Capacity	33.0 cu. m (1,165 cu. ft.)	
Gross Rating	11,340 kg (25,000 lbs.)	
Tare Weight	960 kg (2,115 lbs.)	
Corner Post Rating	5,100 kg (11,250 lbs.)	
	External *(Nominal)*	**Internal**
Length	6,000 mm (20 ft.)	5,943 mm (19 ft. 6 in.)
Width	2,438 mm (8 ft.)	2,388 mm (7 ft. 10 in.)
Height	2,438 mm (8 ft.)	2,311 mm (7 ft. 7 in.)
	Height	**Width**
Door Aperture	2,386 mm (7 ft. 6 in.)	2,386 mm (7 ft. 6 in.)

CERTIFICATIONS

I. Approved for Transport under Customs Seal
II U.I.C Registered
III. Certified Airworthy by F.A.A., Luftfahrt-Bundesamt
IV I.A.T.A Registered

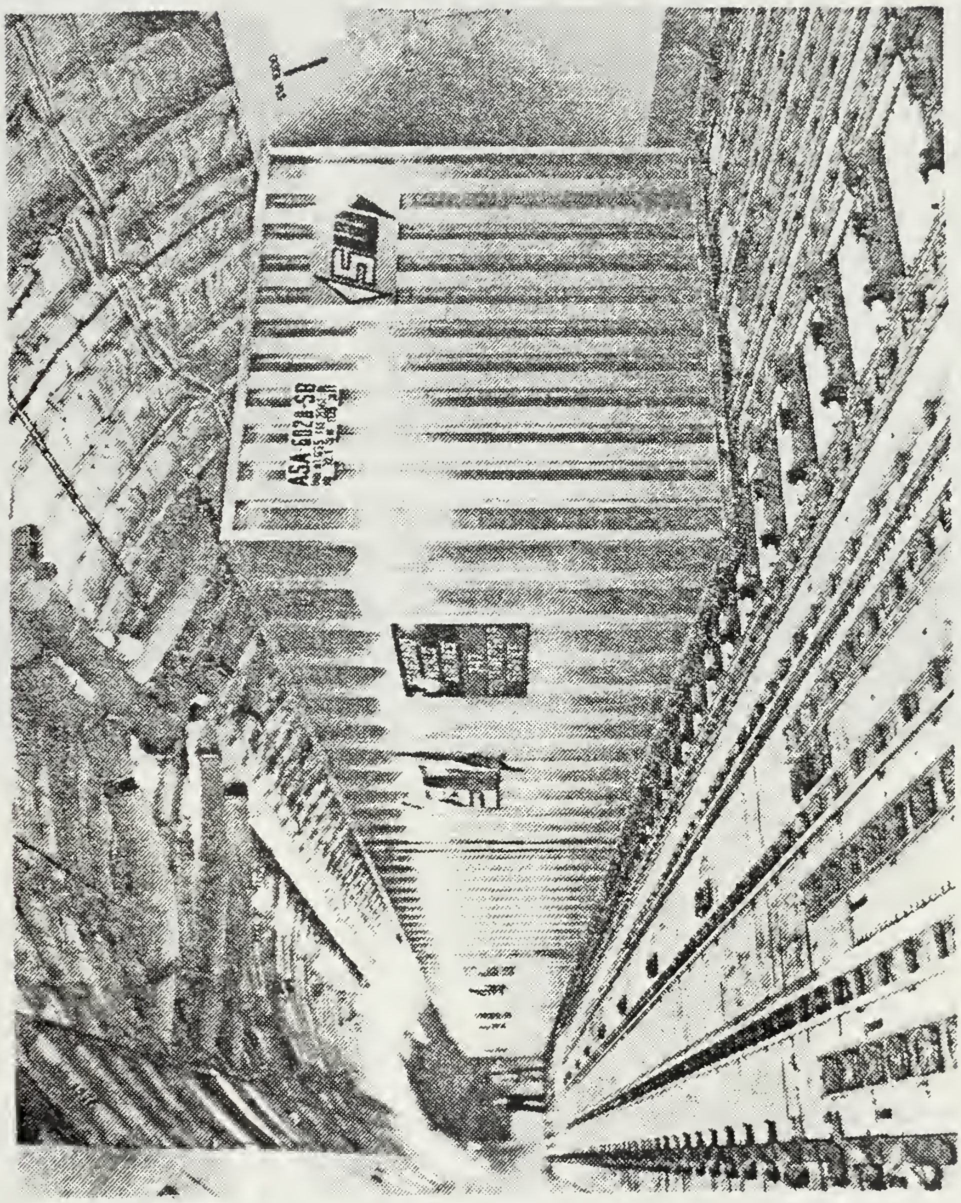
Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.



20' x 8' x 8' Aluminum Air Land Container

Source: CTI Equipment Catalog,
Container Transport International, Inc.
White Plains, N.Y.

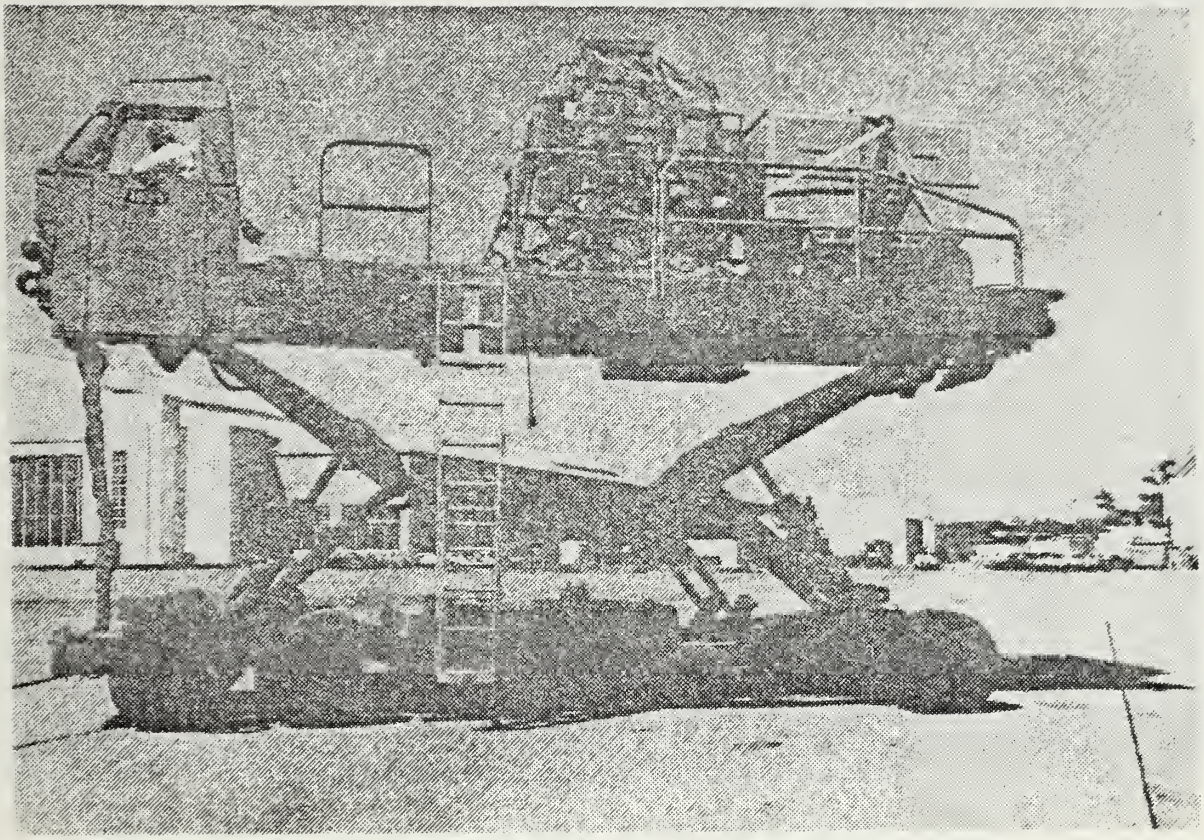
Seaboard World 20'x8'x8' Aluminum Container



Source: Seboard World Airlines,
J. F. Kennedy International Airport,
Jamaica, N.Y.

APPENDIX B

B-1

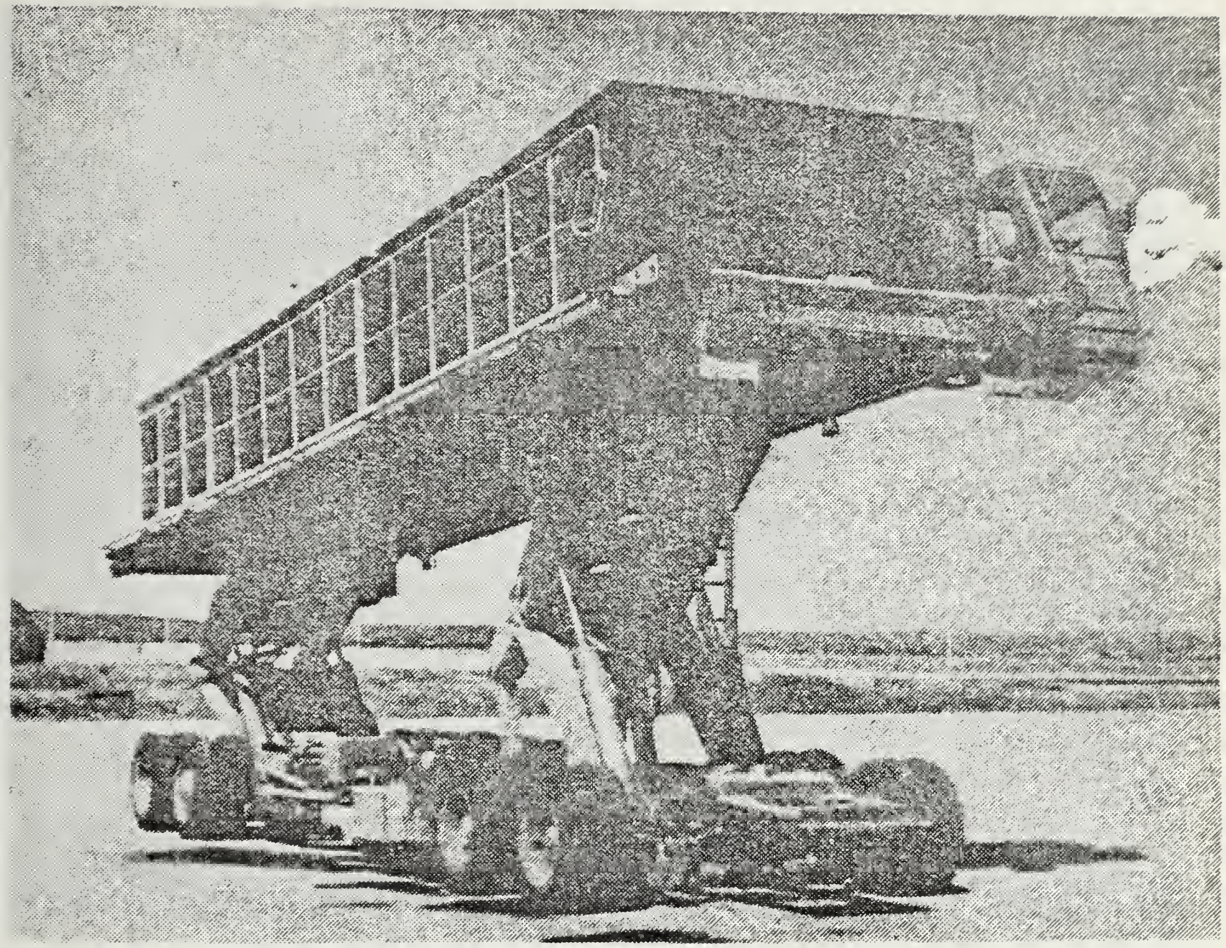


Title: 25K Transporter Loader

Item Description: This item has the capacity to transport 25,000 pound palletized loads to and from military cargo aircraft. It has a platform length of 24 feet, width 10 feet with a lifting range of 3 1/3 feet to 13 feet at 10 FPM and accommodates three 463L pallets.

Program Plan: Available at all aerial ports.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.

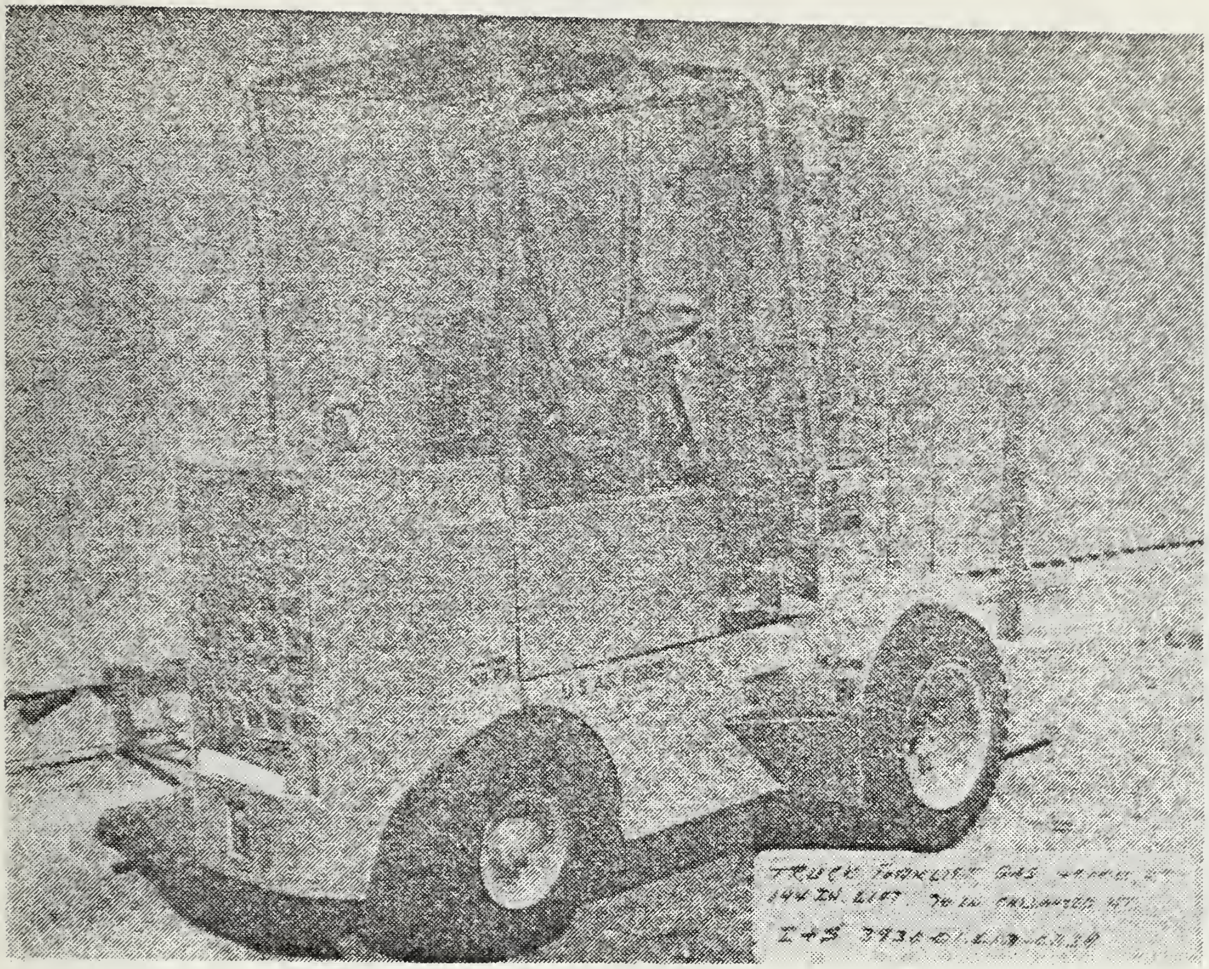


Title: 40K Transporter Loader

Item Description: This item has the capacity to transport 40,000 pound palletized loads to and from military cargo aircraft. It has a platform length of 41 1/2 feet, width 10 feet with a lifting range of 3 1/3 feet to 13 feet at 10 FPM and accommodates five 463L pallets.

Program Plan: Available at all aerial ports.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.



Title: 4,000 pound Capacity Low Mast Forklift Truck

Item Description: This item will provide air bases capability for loading/unloading 8 foot wide by 8 foot high containers. The vehicle has a gasoline powered engine and is capable of lifting 4,000 pounds and a 24 inch load center. It has collapsed mast height of 70 inches with a lift height of 144 inches.

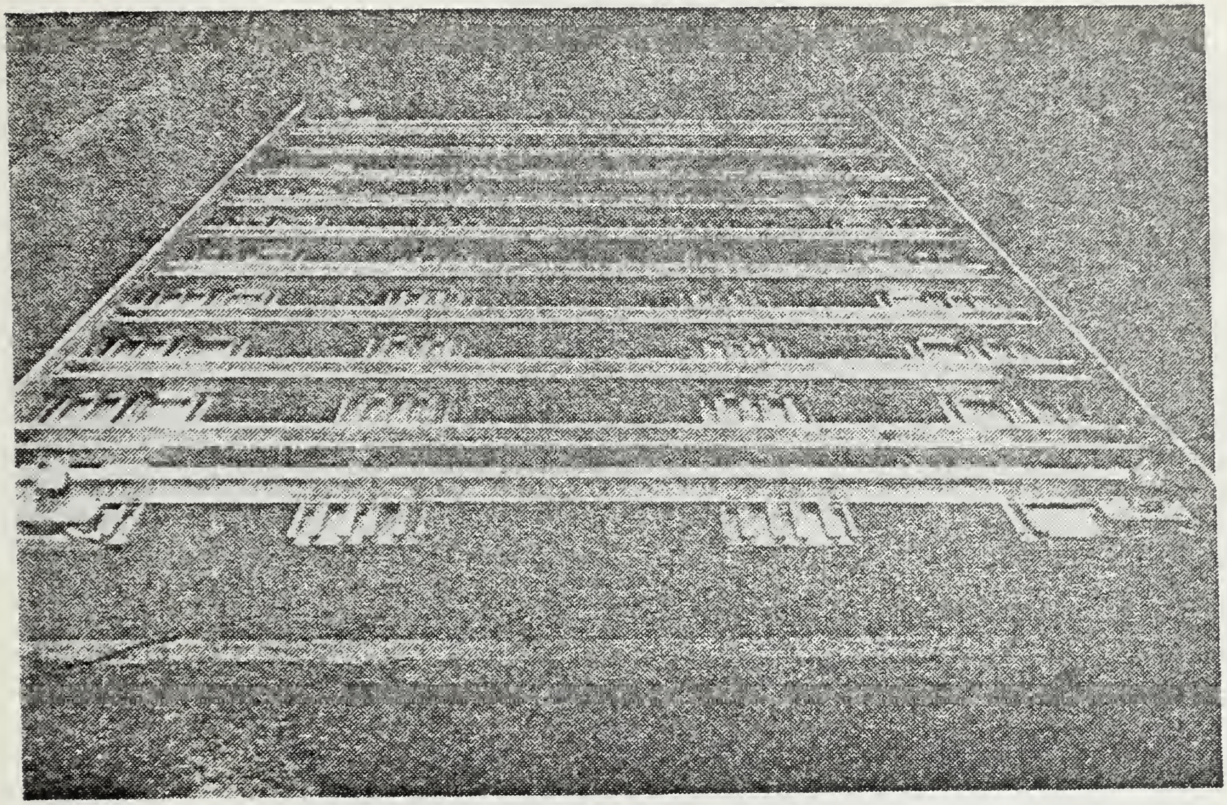
Program Plan: To procure low mast forklifts for Air Force replacements of 4,000 pound trucks.

Status: Procurement of 833 units has been programmed and funded.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.

APPENDIX C

C-1



Title: 463L Adapter Pallet for 20 Foot Containers.

Item Description: The adapter pallet provides means for handling containers in the 463L aircraft material handling system. The pallet adapts the container to military or commercial cargo aircraft roller systems. It provides means for interlocking with the 463L restraint system for palletized cargo.

Program Plan: To procure 2,520 adapters to be prepositioned at aerial ports and terminals to handle ISO configured containers, vans, shelter and special equipment.

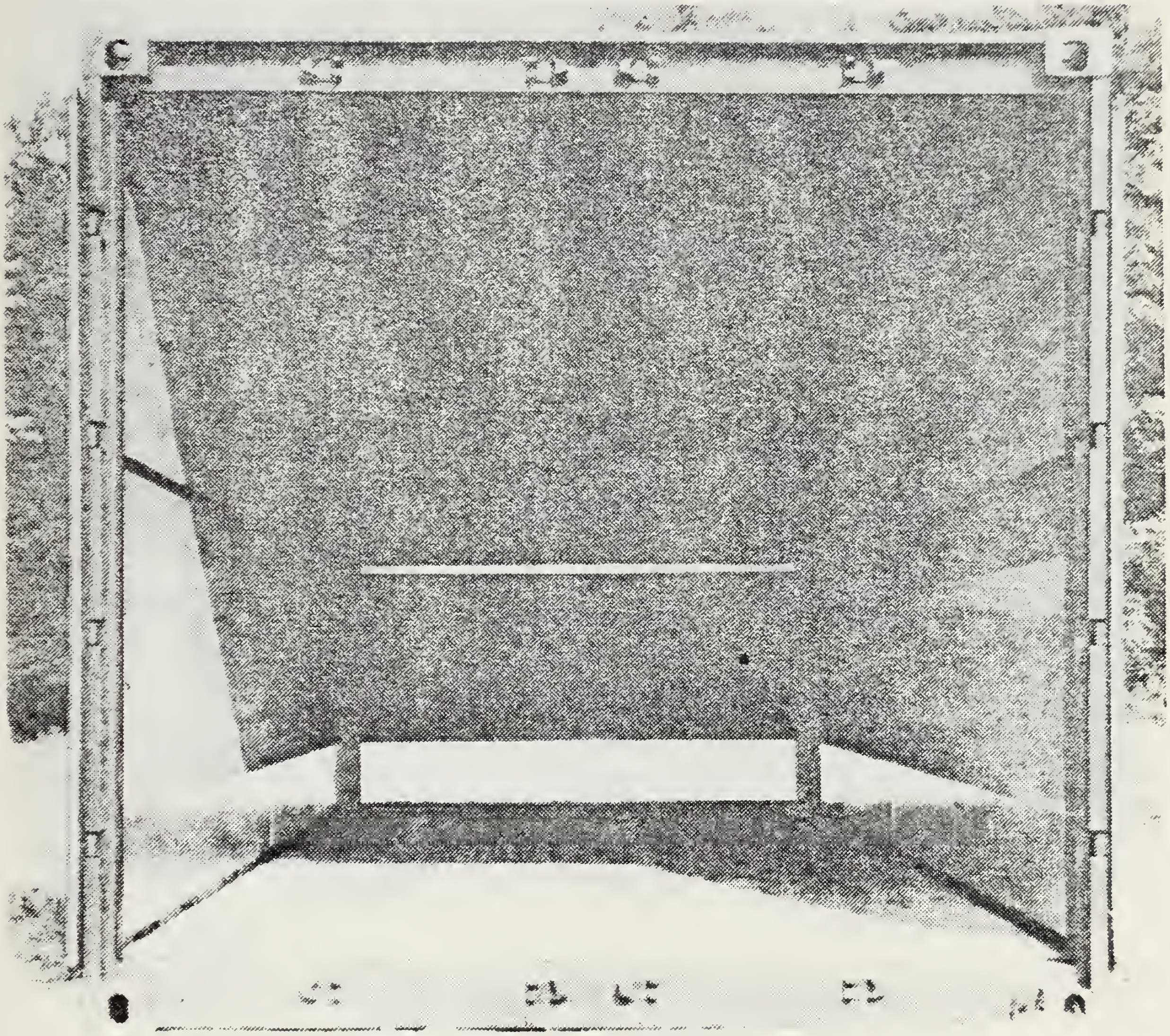
Status: The prototypes have been procured and tested successfully.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.

APPENDIX D

D-1

STANDARD MILVAN



LENGTH: 20 FT

HEIGHT 8 FT

WEIGHT EMPTY: 4700 LBS

WIDTH: 8 FT

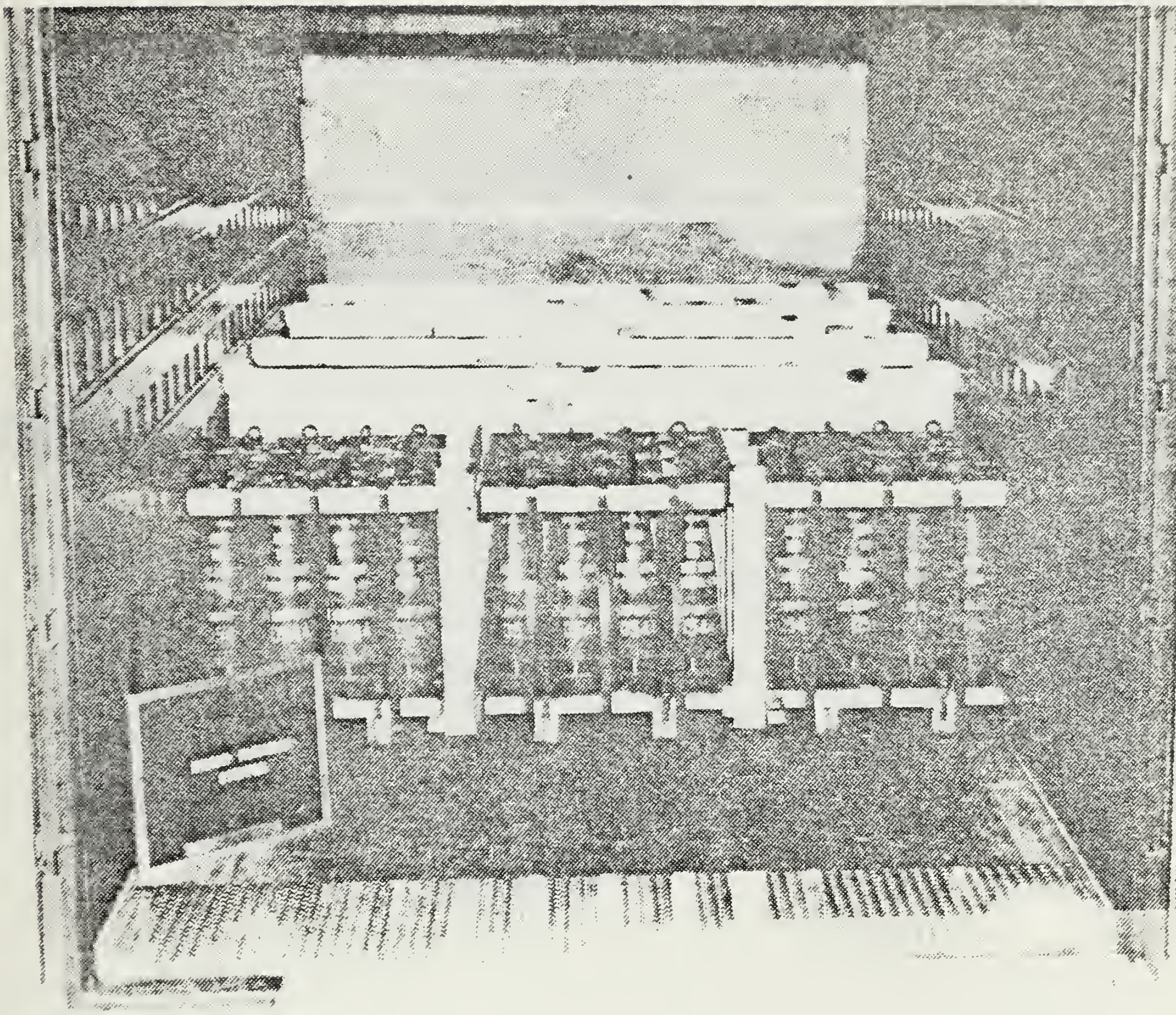
VOLUME INSIDE: 1060 [3]

GROSS WEIGHT: 44,800 LBS

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979

D-2

AMMUNITION MILVAN



LENGTH: 20 FT

WIDTH: 8 FT

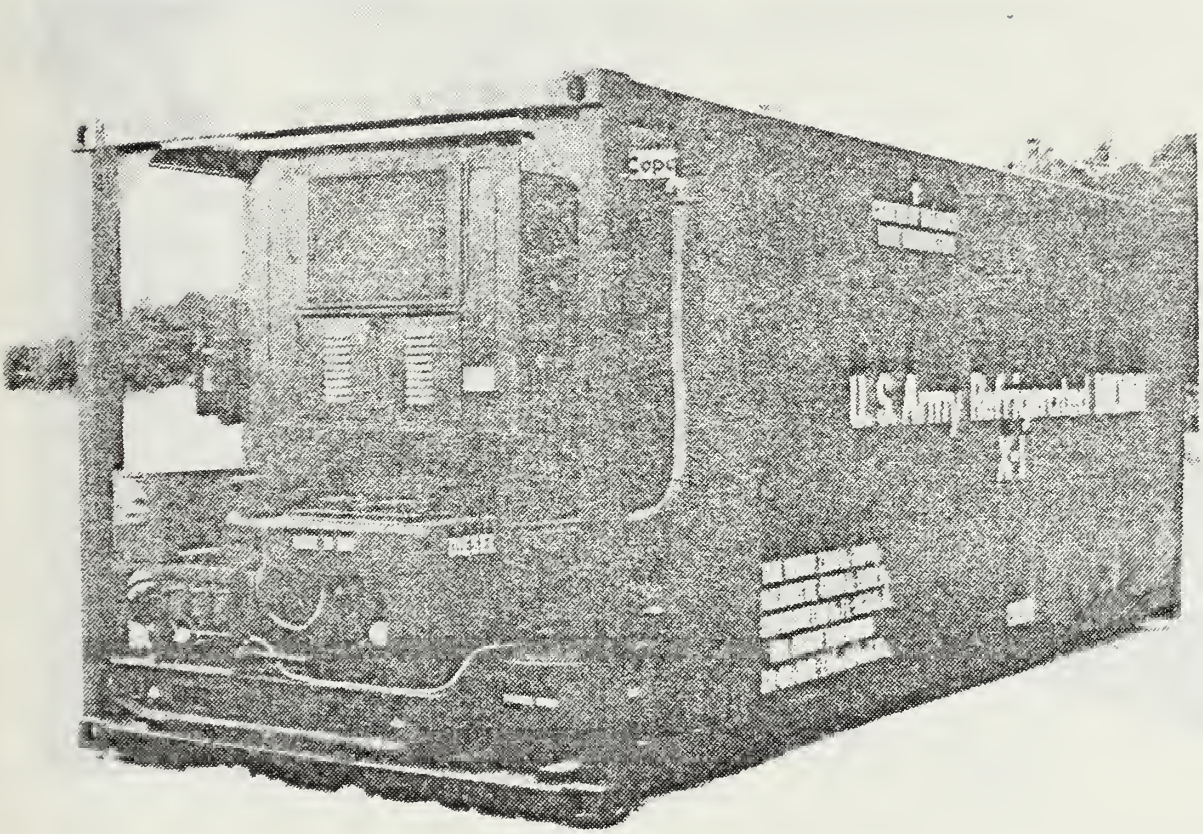
HEIGHT: 8 FT

WEIGHT EMPTY: 5785 LBS

GROSS WEIGHT (DESIGNED): 44,800 LBS

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979

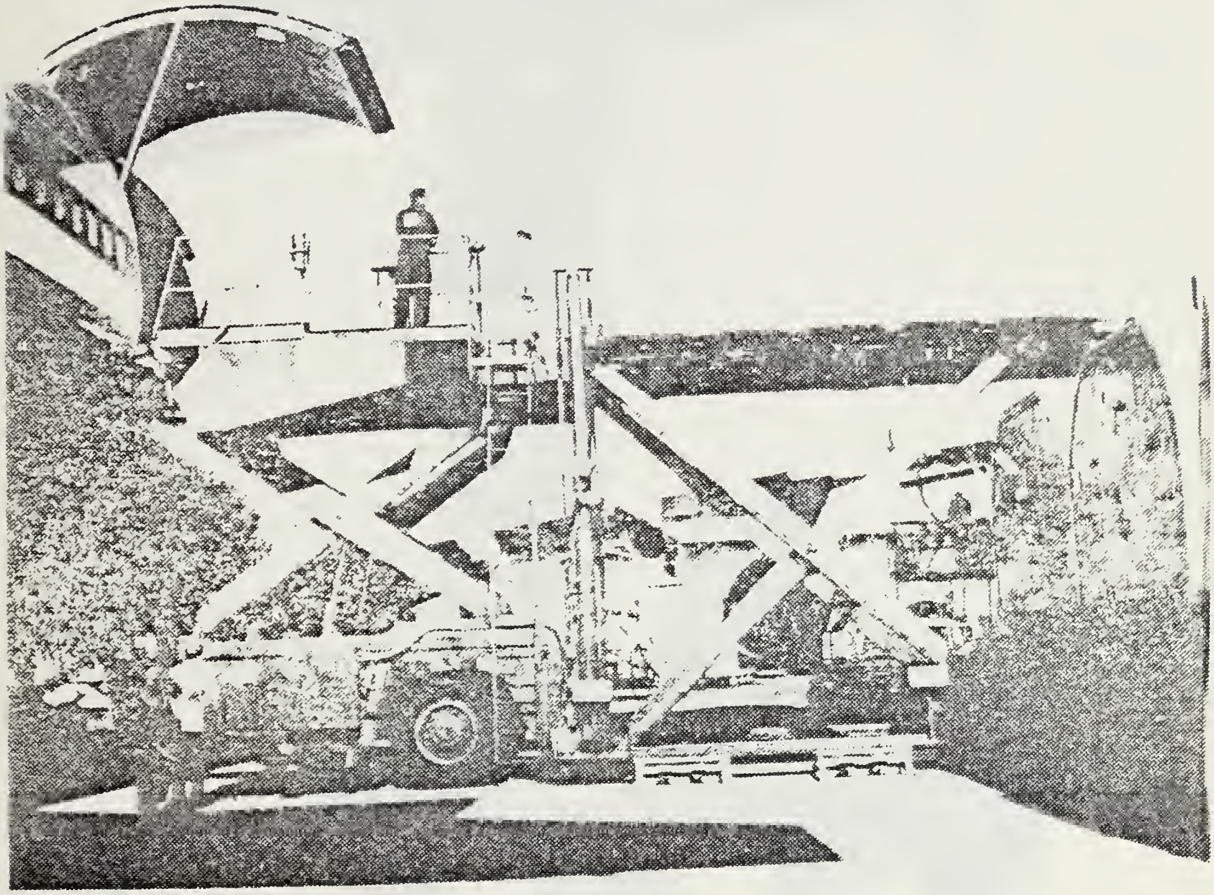
REFRIGERATED MILVAN



LENGTH: 20 FT
HEIGHT: 8 FT
DOOR OPENING WIDTH: 89 IN
WIDTH: 8 FT
DOOR OPENING HT. 82 IN
WEIGHT: 8500 LBS

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979

E-1



Title: Aircraft Mobile Loader

Item Description: This item will provide lifting capability for loading 20 foot containers and palletized cargo into Civil Reserve Air Fleet (CRAF) wide and narrow-bodied aircraft. The lifting height ranges from 1 1/2 feet to 18 1/3 feet, with a 40,000 pound capacity. Platform length is 23 1/4 feet, width is 10 2/3 feet, and accommodates three 463L pallets or one 20 foot container.

Program Plan: To procure 24 mobile loaders.

Status: 24 mobile loaders have been programmed for funding FY79 thru FY82.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.

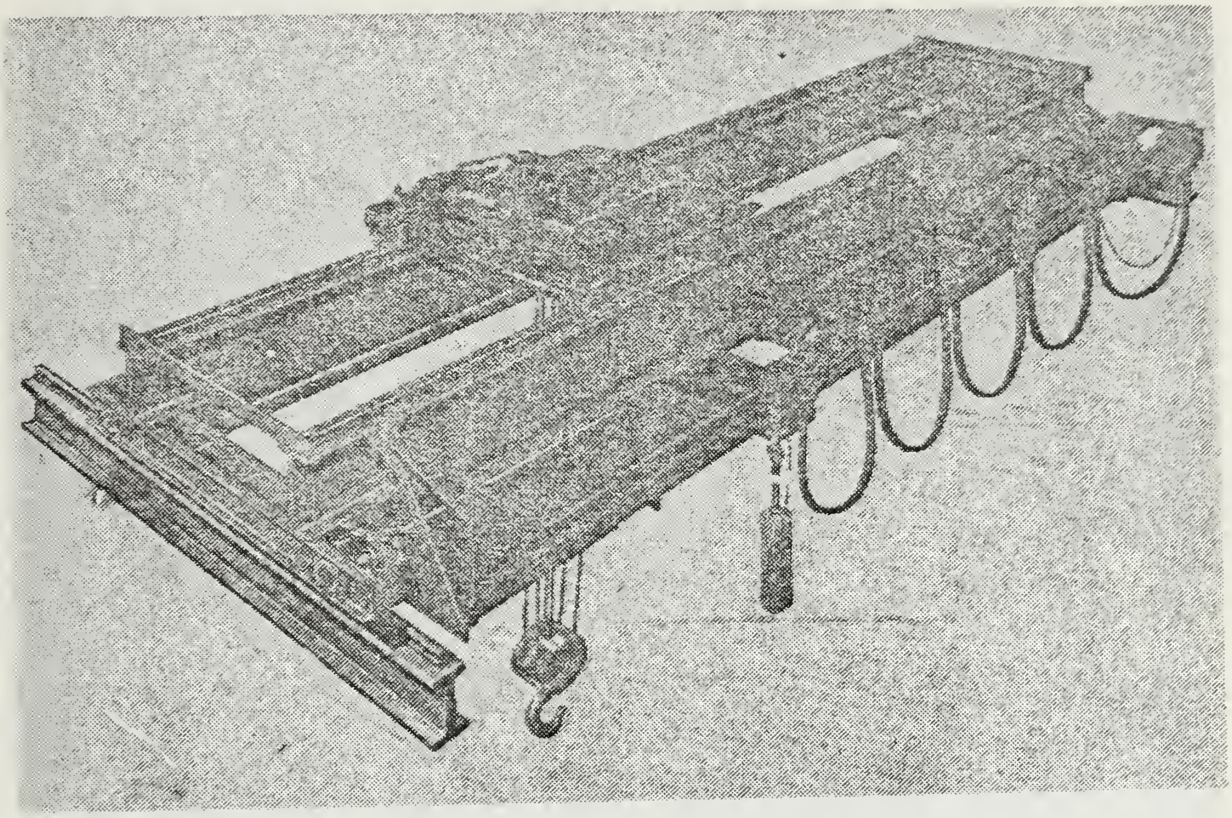
Title: 67,000 pound Capacity Container Handler

Item Description: This item will provide the capability to transfer 8 foot wide containers weighing up to 67,000 pounds and 40 foot in length from line haul trailers/trucks to 463L material handling equipment for loading military or commercial cargo aircraft.

Program Plan: To procure 18 handlers for positioning at major APOD's and APOE's.

Status: Testing of the loading capability of the LeTourneau loader has been completed satisfactorily. Procurement is being programmed for FY 1982 and out years.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.



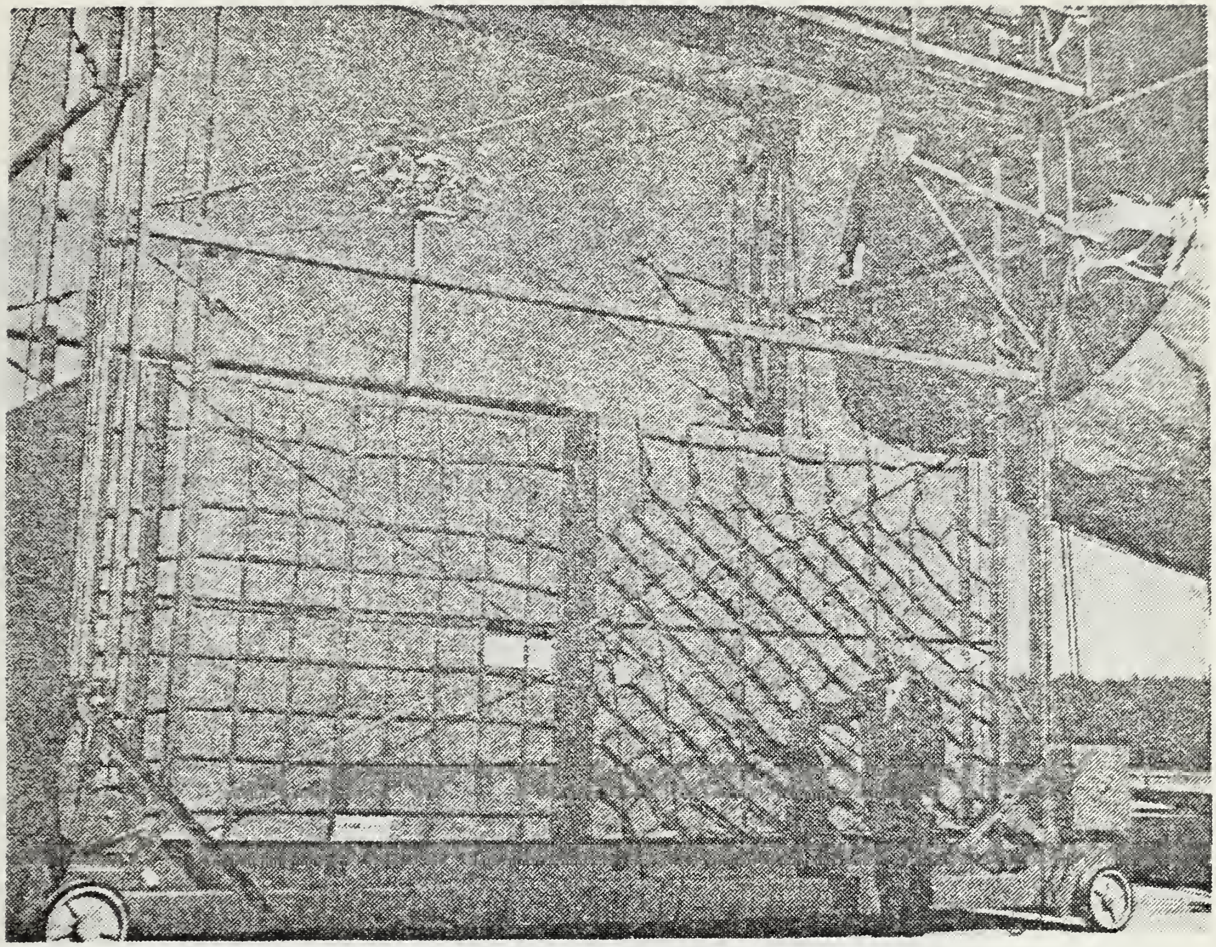
Title: 35 Ton Bridge Crane

Item Description: This item will provide the aerial ports the capability to transfer fully loaded 20 or 40 foot containers from trucks/trailers to pallets and aircraft loaders. Lifting capacity is 62,000 pounds.

Program Plan: Seven cranes have been funded for installation at CONUS ports Dover AFB, DE, and Travis AFB, CA; Europe installations are to be at Mildenhall AB, UK, and Ramstein AB, GE; Pacific installations are to be Clark AB, PI, Kedena AB and Yokota AB, JP.

Status: The cranes are installed and operational at CONUS aerial ports. Contracts for remainder have been let and installation is to be completed by Sept. 30.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.



Title: Elevator Loaders

Item Description: This item will provide an air transportable lifting device for loading/unloading Civil Reserve Air Fleet (CRAF) wide and narrow-bodied aircraft. The lifting height ranges from 1 3/4 feet to 18 feet with a 30,000 pound capacity. Platform length is 21 feet, width is 10 2/3 feet, accommodates three 463L pallets or one 20 foot container. Assembly requires 1 1/2 hours.

Program Plan: To procure 32 elevators.

Status: Thirteen elevators have been procured and deployed. Nineteen more have been programmed for funding FY79 through FY83.

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.

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CONTAINER INSERT

Source: Container System Hardware Status Report, Army Container Oriented Distribution System, Joint Container Steering Group, January 1979.

APPENDIX F

VOLUME OF DOMESTIC INTERCITY FREIGHT TRAFFIC
BILLIONS OF TON-MILES

	TOTAL TRAFFIC VOLUME	RAILROADS VOLUME	RAILROADS % OF TOT	MOTOR VEHICLES VOLUME	MOTOR VEHICLES % OF TOT	AIRWAYS VOLUME	AIRWAYS % OF TOT
1960	1330	594	44.73	285	21.40	.8	.058
1961	1326	586	44.38	296	22.36	1.3	.068
1962	1387	616	43.82	309	22.3	1.3	.093
1963	1469	644	43.65	336	22.89	1.3	.088
1964	1556	679	43.67	356	22.9	1.5	.096
1965	1651	721	43.33	359	21.76	1.9	.116
1966	1759	762	41.79	381	21.66	2.3	.128
1967	1776	742	41.16	389	21.88	2.6	.145
1968	1839	757	40.84	396	21.55	2.9	.157
1969	1895	774	39.83	404	21.32	3.2	.168
1970	1936	771	38.19	412	21.28	3.3	.170
1971	1953	746	37.8	445	22.78	3.5	.170
1972	2071	783	38.51	470	22.7	3.7	.179
1973	2232	858	38.52	505	22.66	3.9	.175
1974	2212	852	36.39	495	22.38	3.9	.180
1975	2080	757		488	23.46	3.7	.192

1975 Railroad % OF TOTAL not available
Inland Waterways, Oil Pipelines Deleted

Source: Statistical Abstracts of the United States, U.S. Department of Commerce, Bureau of the Census, Washington, 1977.

APPENDIX G

SUMMARY OF TONNAGE MOVED BY MILITARY AIRLIFT COMMAND 1968-1978

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74	FY 75	FY 78	FY 7T	FY 77	FY 78
Channel Cargo	679079	725322	658643	526757	516998	451142	290947	273324	265258	58223	271358	280549
Special Assignment Airlift Missions	97667	74727	57037	65813	101733	59545	64514	78107	57376	11437	66644	82609
Total	776746	800049	715680	592570	618731	510687	355461	351431	322634	69660	338002	363158

NOTES:
1. Fiscal years (FY 68 76 went from 1 July of the year previous to 30 June of the nominal year. In other words FY 68 started 1 July 1967 and ended 30 June 1968.
2. Fiscal year 7T went from 1 July 1976 to 30 Sep 76.
3. Subsequent fiscal years go from 1 Oct of the year previous to 30 Sep of the nominal year. In other words FY 78 started 1 Oct 1977 and ended 30 Sep 1978.
4. "Channel" is normal aerial port traffic moved through scheduled missions.
5. Special Assignment Airlift Missions are non-scheduled missions operated at the request of DOD departments.

SUMMARY OF PASSENGERS MOVED BY MILITARY AIRLIFT COMMAND 1968-1978

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 7T	FY 77	FY 78
Channel Passengers	2700266	2920436	2890514	2546098	1906802	1411211	1137696	1091546	1048418	280330	1062593	991468
Special Assignment Airlift Missions	365826	355091	304485	82512	107624	174473	110437	213064	141927	28843	186620	270078
DOD Space Available	277536	335984	372824	359977	336229	309832	282254	309140	249359	59952	248653	290609
Total	3343628	3611511	3567823	2988587	2350655	1895516	1530387	1613750	1439704	369125	1497866	1552155

Source: <u>Military Airlift Command</u>, Defense Transportation Journal, Volume 35, Number 1, February 1979.

APPENDIX H

SHIPMENTS FROM TRAVIS AIR FORCE BASE
MONTH OF APRIL 1979

DESTINATION	HIGH PRIORITY # OF SHIPMENTS	HIGH PRIORITY TONS	REGULAR SHIPMENT # OF SHIPMENTS	REGULAR SHIPMENT TONS	TOTAL # OF SHIPMENTS	TOTAL TONS
ADAK	0	0	2	.7	2	.7
KING SALMON	0	0	2	.1	2	.1
ALICE SPRINGS	0	0	48	10.4	48	10.4
BITBURY	0	0	1	.5	1	.5
BANGKOK	2	4.0	26	18.3	28	22.3
CHRIST CHURCH	19	1.2	36	2.9	55	4.1
CANTON ISLAND	0	0	13	3.3	13	3.3
CLARK AFB	144	40.5	940	141.8	1068	182.5
CUBI POINT	596	85.0	1669	180.8	2376	265.9
DHAHRAN	1	.4	0	0	1	.4
DJAKARTA	10	3.5	42	16.1	52	19.6
KADENA	104	34.4	132	49.9	237	74.3
ELMENDORF	32	16.4	123	24.7	156	41.1
EIELSON	4	1.1	23	1.6	28	2.8
ENEWETOK	46	18.8	51	17.5	98	36.3
RHEIN-MEIN	13	2.1	179	33.7	198	36.4
GUANTANAMO	0	0	1	.1	1	.1
HICHAM AFB	309	63.2	2614	263.9	2941	327.4
HOWARD	1	.1	0	0	1	.1
IWO JIMA	0	0	1	.1	1	.1
JOHNSTON IS.	1	.1	18	4.0	19	4.1
KUNSAN	0	0	4	.5	4	.5
KWAJALEIN	10	2.0	68	13.3	78	15.3
KWANG JU	0	0	1	.1	1	.1
HAROLD E. HOLT	4	1.0	67	13.9	71	14.9
MIDWAY	1	.3	17	5.2	18	5.5
MILDENHALL	7	24.2	8	4.7	15	28.9
MISAWA	2	2.4	9	1.6	11	4.0
DIEGO GARCIA	75	12.7	153	14.2	230	26.9
YOKOTA	67	22.5	205	20.7	272	43.2
OSAN	160	235.2	498	352.9	678	607.8
RICHMOND	1	.4	39	3.6	40	4.0
RAMSTEIN	49	28.5	197	33.8	250	62.3
SOCSTENBERG	0	0	1	.1	1	.1
SPARREVOHN	0	0	1	.1	1	.1
SHEMYA	3	.6	9	1.9	12	2.5
TAEGU	6	2.4	24	4.8	30	7.2
TENGAU	6	.3	27	.6	3	.9
TEMPELHOF	0	0	6	.3	6	.3
TAIPEI	0	0	6	.8	6	.8
GUAM	88	22.6	1364	138.8	1466	161.6
WOONEKA	2	.1	61	18.3	63	18.4
TOTALS	1,734	626.6	8,788	1,390.6	10,617	2,038.3

Source: Naval Liaison Officer, 22nd Air Force, Travis Air Force Base.

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